Project:

MaNaCa

(Grant Agreement number 857502)

"Magnetic Nanohybrids for Cancer Therapy "

Funding Scheme: Coordination and Support Action
Call: H2020-WIDESPREAD-2018-2020 / H2020-WIDESPREAD-2018-03
Date of the latest version of ANNEX I: 6/6/2019

D4.2 Year 1 report on Events (Workshops, Summer Schools, Conferences)

Project Coordinator (PC):	Dr. Aram MANUKYAN Email: manukyan.ipr@gmail.com
PC Organization Name:	IPR-NAS
Lead Partner for Deliverable:	IPR-NAS
Deliverable Due Date:	30/9/2020
Deliverable Issue Date:	12/6/2021

Document History

(Revisions – Amendments)

Version and date	Changes
1.0 – 28/9/2020	First version
1.1 – 30/9/2020	Reviewed and proof-read by consortium partners
1.2 – 12/6/2021	Updated to include section on plans to publish intermediate results

Dissemination Level		
PU	Public	**X**
PP	Restricted to other program participants (including the EC Services)	
RE	Restricted to a group specified by the consortium (including the EC Services)	
CO	Confidential, only for members of the consortium (including the EC)	

The MaNaCa project intends to develop the scientific and technological capacity as well as raising the research profile of the Institute for Physical Research of the National Academy of Sciences (IPR-NAS) in Armenia. From a scientific standpoint, MaNaCa will focus on the structural and magnetic characterization of magnetic nanohybrids and their application for cancer therapy. The project's aim will be accomplished by networking IPR-NAS with two internationally-leading research organisations: the Aristotle University of Thessaloniki (AUTH) in Greece and the University of Duisburg – Essen (UDE) in Germany. Throughout the project, the research partners will be supported for management ad dissemination by Intelligentsia Consultants Sàrl (INT), a consultancy company based in Luxembourg which has already collaborated on several occasions with the Widening partner. During the project, which will have a total duration of three years, the partners will carry out a research and innovation strategy with these objectives:

1. Stimulating scientific excellence and innovation capacity of IPR-NAS with regard to magnetic nanohybrids for cancer therapy.
2. Improve the career prospects of early stage researchers of IPR-NAS and the Twinning partners
3. Raise the research profile of IPR-NAS and the Twinning Partners

In order to accomplish this task, the consortium partners will implement several actions through the project's work packages: (WP1) exchange of senior researchers; (WP2) exchange of early stage researchers; and (WP3) dissemination and outreach. Project management (WP4) will be coordinated by IPR-NAS with the support of INT. In addition to staff exchanges, project's activities will include technical training, joint publications, joint participation to conferences, organization of summer schools, workshops and an international conference.

Table of Contents

1. Executive Summary

During Year 1 the consortium partners have successfully held two training workshops and one summer school thereby reaching Milestone 3 (2 workshops organized during Year 1) and Milestone 5 (1 summer school organized during Year 1) of the project:

- 1st Training Workshop during 27-28 July 2020 (Zoom).
- 2nd Training Workshop during 25-28 August 2020 (Hybrid: Zoom/Thessaloniki).
- 1st Summer School during 25-28 August 2020 (Hybrid: Zoom/Thessaloniki).

The consortium was obliged to hold the events online due to the international travel restrictions imposed by the COVID-19 pandemic. In the case of the combined 2nd Training Workshop and 1st Summer School event held in Thessaloniki, the local participants were able to attend in person.

Also, the partners have presented the MaNaCa project's activities and its results during two workshops:

- International Workshop SpinS during 2-4 October 2019 (Location: Duisburg, Germany).
- 2nd Training Workshop during 25-28 August 2020 (Hybrid: Zoom/Thessaloniki).

2. Training Workshops

2.1 1st Training Workshop during 27-28 July 2020 (Zoom)

Originally, the 1st Training Workshop was foreseen to take place in person at AUTH, Thessaloniki, Greece, in early April 2020. However, due to the COVID-19 pandemic and the lockdown situation across Europe in Spring 2020, AUTH's Training Workshop was postponed until late August 2020 and, in its place, the 1st Training Workshop became an online-only event held during 27-28 July 2020.

The training workshop included talks on the preparation and presentation of scientific publications, project management, and an introduction to Electronic Lab Notebooks. The full workshop programme is provided in Annex 1.

The following 38 people (33 x early stage researchers, 5 x senior researchers, 58% female) participated in the workshop. The full list of participants of the workshop is provided in Annex 2.

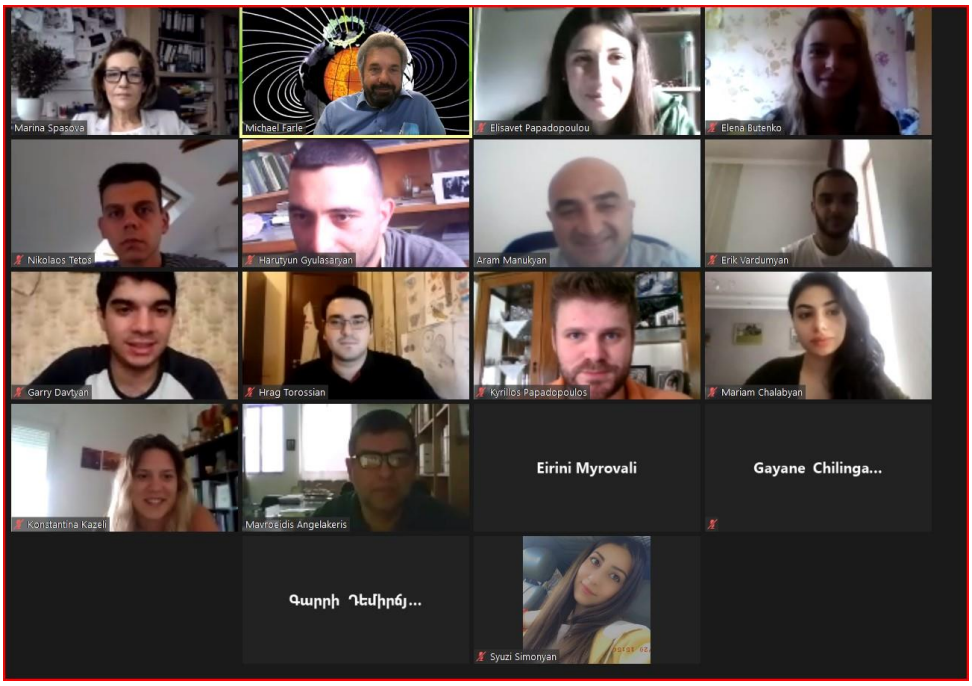

Figure 1: Screenshot of participants during the 1st Web-Based Training Workshop

2.2 2nd Training Workshop during 25-28 August 2020 (Hybrid: Zoom/Thessaloniki)

A combined 2nd Training Workshop and 1st Summer School were held in Thessaloniki, Greece, during 25-28 August 2020 (see http://magnacharta.physics.auth.gr/manaca-workshop.htm). The combined workshop and summer school was a hybrid event – with both on-site and web participation – which focused on structural and magnetic characterization of magnetic nanohybrids and their application to cancer therapy aiming to provide training in the basic principles of nanomagnetism and its biomedical applicability through 22 fundamental lectures, while offering the latest insights into up-to-date aspects of magnetically driven cancer therapies. A copy of the event's book of abstracts is provided in Annex 3.

The workshop programme consisted of 22 tutorial lecture sessions by experts in the fields divided in four sessions: a). Materials & Structure, b). Magnetism & Properties, c). Biomedical Constraints and d). Cancer Specific Aspects. A copy of the event's scientific programme is provided in Annex 4.

The workshop/summer school - with 78 participants from 11 countries - was held in English and addressed towards Greek and foreign graduates and PhD students, as well as to post-doc and young researchers (61 in total) working in the field of magnetic nanomaterials focusing on their biomedical applicability. A copy of the list of participants is provided in Annex 5.

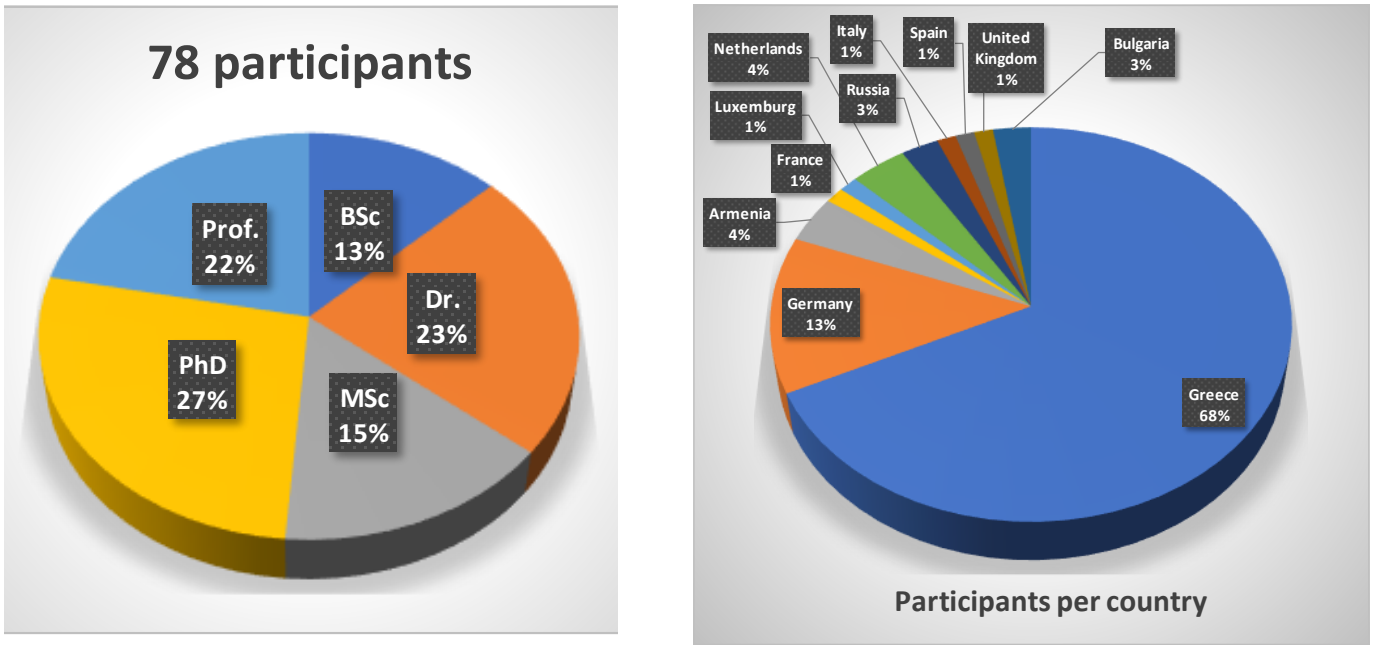

Figure 2. Breakdown of the participants in the combined 2nd Training Workshop and Summer School

Figure 3: Participants in the 2nd Training Workshop & 1st Summer School, Thessaloniki, Greece

Figure 4: Scenes from the 2nd Training Workshop & 1st Summer School, Thessaloniki, Greece

3. Summer Schools

3.1 1st Summer School during 25-28 August 2020 (Hybrid: Zoom/Thessaloniki)

The Summer School involved four Lab Courses that took place during the afternoons, which the students had the chance to follow:

Tuesday, August 25, 2020 17^{30}-19^{30} Lab Course 01: Young researchers: Present & Publish
M. Farle, Germany: How to make a good scientific oral presentation
C. Bratsas & S. Zapounidou, Greece: How to avoid predatory journals and plan your publication strategy
Oral presentations at a conference or internal seminar are for sharing your research work with other scientists. They must convince the audience that the research presented is important, valid, and relevant to them. Predatory publishing, sometimes called write-only publishing or deceptive publishing, is an exploitive academic publishing business model.

A video recording of Lab Course 01 is available here:
https://drive.google.com/file/d/1UQTADlW8fcuxm2BT9U4fzo056GGKGLoL/view?usp=sharing

Wednesday, August 26, 2020 17^{30}-19^{30} Lab Course 02: Young researchers: Propose & Manage
G. Brandon, Luxembourg: H2020 MSCA Individual Fellowships for the young researchers
What are the MSCA Individual Fellowships? Grants provided by Marie Skłodowska-Curie Actions are available for all stages of a researcher's career, irrespective of nationality. Fellows include PhD candidates and those carrying out more advanced research. Researchers working across all disciplines, from life-saving healthcare to 'blue-sky' science, are eligible for funding.

A video recording of Lab Course 02 is available here:
https://drive.google.com/file/d/1py13_21WsEdtJdtaGSoogc578LahiImK/view?usp=sharing

Thursday, August 27, 2020 17^{30}-19^{30} Lab Course 03: Young researchers: Samples & Biomedicine
E. Myrovali & K. Kazeli, Greece: Hands on Samples for biomedical applications
Iron oxide nanoparticles have emerged as one of the primary nanomaterials for biomedical applications due to their long blood retention time, their biodegradability and their low toxicity. They can be used in technological applications, including clinical needs such as magnetic hyperthermia. First, we present the synthetic route using the aqueous chemical coprecipitation method. Next, we present the fabrication processes used to produce phantom with agarose solution. Gels and especially those from agarose, are routinely used as phantom models while they comprise the only transparent porous materials which successfully simulate animal tissues and we conclude with in-vitro experimental sequences.

A video recording of Lab Course 03 is available here:
https://drive.google.com/file/d/12nlpU9ehL3ROYf25ncVm7EnrFI3QEz7l/view?usp=sharing

Friday, August 26, 2020 17^{30}-19^{30} Lab Course 04: Young researchers: Magnetic Hyperthermia
A.R. Tsiapla, N. Maniotis, A. Makridis, Greece: Hands on Magnetic Particle Hyperthermia: Experiment & Evaluation
This Lab Course is focusing on the experiment as well as on the evaluation of Magnetic Particle Hyperthermia. Adjusted protocols and experimental strategies will be presented, targeting to the best heating results under harmless routes. Moreover, we will demonstrate computationally a strategy, to mitigate eddy currents heating, by applying the external magnetic field intermittently (in an ON/OFF fashion), instead of the continuous mode typically used in Magnetic Hyperthermia studies.

A video recording of Lab Course 04 is available here:
https://drive.google.com/file/d/1LrNMctFxMposwqy6TrxUje1ZOGvNI0yM/view?usp=sharing

Also, the Summer School included two flash presentation web-poster sessions for young researchers (Thursday and Friday afternoon), where they had the chance to present their results while onsite participants hung printouts of their posters and discussed their results during the workshop breaks.

A video recording of the web-poster sessions is available here:
https://drive.google.com/file/d/1wO1yDQ1nREnUmd-Iakx35i-qFXyve6v7/view?usp=sharing

4. Participation in Conferences/Workshops

During Year 1 the consortium partners have presented the MaNaCa project's activities and its results during two workshops.

Name and location of conference/workshop	International Workshop SpinS, Duisburg, Germany
Dates of conference	2-4 October 2019
Name(s) of researcher(s) attending conference/workshop	Dr. Aram Manukyan, MaNaCa Coordinator
Title of paper presented at the conference/workshop	*Synthesis and Characterization of Carbon Coated Fe-Fe_3C "Core-Shell" Nanoparticles for Magnetic Hyperthermia*, Aram Manukyan, Institute for Physical Research, National Academy of Sciences of Armenia, Ashtarak

Name and location of conference/workshop	2nd MaNaCa Workshop, Thessaloniki, Greece
Dates of conference	25-28 August 2020
Name(s) of researcher(s) attending conference/workshop	Dr. Aram Manukyan (IPR-NAS), Gayane Chilingaryan (IPR-NAS), Harutyun Gyulasaryan (IPR-NAS), Elisavet Papadopoulou (UDE)
Title of paper presented at the conference/workshop	1. *Iron based "Core-Shell" Nanoparticles for Magnetic Hyperthermia of Cancer Cells*, Aram Manukyan, Institute for Physical Research, National Academy of Sciences of Armenia, Ashtarak, Armenia. 2. *Fe-Fe_3O_4 "Core-Shell" Nanoparticles: Synthesis and Characterization*, Gayane Chilingaryan, Institute for Physical Research, National Academy of Sciences of Armenia, Ashtarak, Armenia. 3. *Fe-Fe_3C "Core-Shell" Nanoparticles: Synthesis and Characterization*, Harutyun Gyulasaryan, Institute for Physical Research, National Academy of Sciences of Armenia, Ashtarak, Armenia. 4. *Magnetic characterization of Fe/Fe_3C nanoparticles fabricated by solid state pyrolysis*, Elisavet Papadopoulou, Fakultät für Physik, Universität Duisburg-Essen, Germany.

5. Plans to Publish Intermediate Results

In the near future, the consortium partners will take part in several conferences devoted to the synthesis and investigation of magnetic nanohybrids for biomedical applications. Until the beginning of 2022, partners will participate in the following events:

1. ICNN 2021: 15. International Conference on Nanomedicine and Nanotechnology, Paris, France, 30-31 December 2021
   https://waset.org/nanomedicine-and-nanotechnology-conference-in-december-2021-in-paris

2. NanoMedicine International Conference Milano, Italy, 20 – 22 October 2021
   https://www.setcor.org/conferences/nanomed-2021/conference-fee

3. 15th Joint MMM-INTERMAG Conference, New Orleans, USA, 10 - 14 January 2022
   https://magnetism.org

4. DPG-Frühjahrstagung (DPG Spring Meeting) of the Condensed Matter Section (SKM), Regensburg, Germany, 6 – 11 March 2022

Currently, two manuscripts are being prepared, which are expected to be submitted to one of the following journals:

- Journal of Magnetism and Magnetic Materials,
- RSC Advances
- Physical Chemistry Chemical Physics
- Journal of Applied Physics

Manuscript 1

Synthesis, Structure, Magnetic and Magnetic Particle Heating Characterization of Fe/Fe 3 C Nanoparticles in Carbon Matrix

H.T. Gyulasaryan[1], G.K. Chilingaryan[1], E. Papadopoulou[2], N. Tetos[2], N. Sisakyan[1], E.G. Sharoyan[1], E. Myrovali[3], A. Makridis[3], M. Angelakeris[3], M. Farle[2], M. Spasova[2], A.S. Manukyan[1]

[1]Institute for Physical Research, National Academy of Sciences, Ashtarak, 0203 Armenia

[2] Faculty of Physics and Center of Nanointegration (CENIDE), University of Duisburg-Essen, Duisburg, 47057 Germany

[3] Physics Department, Aristotle University of Thessaloniki, 54124 Greece

Manuscript 2

Structure and magnetism of Fe/Fe_3C-Carbon nanocomposites. Influence of the pyrolysis parameters

E. Papadopoulou[1], N. Tetos[1], H.T. Gyulasaryan[2], A.S. Manukyan[2], E. Myrovali[3], A. Makridis[3], M. Angelakeris[3], M. Farle[1], M. Spasova[1]

[1] Faculty of Physics and Center of Nanointegration (CENIDE), University of Duisburg-Essen, Duisburg, 47057 Germany

[2] Institute for Physical Research of National Academy of Sciences (IPR-NAS), Ashtarak, 0203 Armenia

[3] Physics Department, Aristotle University of Thessaloniki, 54124 Greece

Furthermore, during Period 2, the partners anticipate publishing other research articles in nanomedicine and magnetism journals, in particular in the International Journal of Nanomedicine, International Journal of Hyperthermia, and Journal of Magnetism and Magnetic Materials.

Annex 1

Programme of the 1st Web-based Training Workshop via ZOOM

MaNaCa Twinning|Horizon2020 project No 857502 (2019-2022)

https://uni-due.zoom.us/j/97942875688?pwd=RStkS0FRK1FoQjMza01uNmVwTXZJdz09
Meeting-ID: 979 4287 5688; Kenncode: 868142
Moderated by Marina Spasova

GER	GR	ARM	Monday, 27.07.20	Tuesday, 28.07.20
09:00 09:30	10:00 10:30	11:00 11:30	**Opening/ZOOM Test**	**Flavien Massi** Project management (Part 1)
09:30 10:30	10:30 11:30	11:30 12:30	**Makis Angelakeris** Action steps for a sound scientific publication	
10:30 11:00	11:30 12:00	12:30 13:00	**Coffee break**	**Coffee break**
11:00 12:00	12:00 13:00	13:00 14:00	**Vardan Gevorgyan** How to prepare and deliver effective business presentation	**Flavien Massi** Project management (Part 2)
12:00 13:30	13:00 14:30	14:00 15:30	**Lunch**	**Closing**
13:30 14:30	14:30 15:30	15:30 16:30	**Sarah Ann Danker & Henning Timm** An Introduction to Electronic Lab Notebooks	
14:30 15:30	15:30 16:30	16:30 17:30	**Michael Farle** How to prepare, submit and publish a scientific manuscript?	
15:30 16:00	16:30 17:00	17:30 18:00	**Coffee break**	
16:00 17:00	17:00 18:00	18:00 19:00	**Michael Farle** How to prepare a scientific presentation and be remembered?	

Annex 2

Participants in the 1st Web-based Training Workshop

	Name, Surname	University, Workplace
1	Elen Sahakyan, MSc Student (F)	Yerevan State Medical University (YSMU), Armenia
2	Sona Babayan, PhD Student (F)	National Polytechnic University of Armenia
3	Anna Avagyan, MSc Student (F)	YSMU
4	Anna Tahmazyan, MSc Student (F)	YSMU
5	Ruzamma Shushanyan, MSc Student (F)	YSMU
6	Garri Demirchyan, PhD Student (M)	Center for Ecological-Noosphere Studies National Academy of Sciences, Russia
7	Katarine Fereshetyan, MSc Student (F)	YSMU
8	Nazeli Gevorgyan, MSc Student (F)	YSMU
9	Arpine Torosyan, MSc Student (F)	YSMU
10	Marine Mardiyan, MSc Student (F)	YSMU
11	Marieta Rushanyan, MSc Student (F)	YSMU
12	Syuzanna Torosyan, MSc Student (F)	YSMU
13	Hrak Torosyan, MSc Student (M)	YSMU
14	Erik Vardumyan, MSc Student (M)	YSMU
15	Mariam Chalabyan, MSc Student (F)	YSMU
16	Garri Davtyan, MSc Student (M)	YSMU
17	Mariam Movsisyan, MSc Student (F)	YSMU
18	Sona Khachatryan, MSc Student (F)	YSMU
19	Aram Manukyan, Dr. Senior Researcher (M)	IPR NAS
20	Harutyun Gyulasaryan, PhD Student (M)	IPR NAS
21	Gayane Chilingaryan, PhD Student (F)	IPR NAS
22	Areg Kocharyan, PhD Student (M)	IPR NAS
23	Elena Butenko, PhD Student (F)	MAX laboratory of Kirensky Institute of Physics, Krasnoyarsk, Russia
24	Daria Chimitdorzhieva, PhD Student (F)	MAX laboratory of Kirensky Institute of Physics, Krasnoyarsk, Russia
25	Makis Angelakeris, Prof. Dr. (M)	AUTH
26	Eirini Mirovali, Post-Doc (F)	AUTH
27	Antonis Makridis, Post-Doc (M)	AUTH
28	Nikos Maniotis, Post-Doc (M)	AUTH
29	Caterina Tsiapla, PhD Student (F)	AUTH
30	Konstantina Kazeli, MSc gradaute (F)	AUTH
31	Kyrillos Papadopoulos, MSc student (M)	AUTH
32	Michael Farle, Prof. Dr. (M)	UDE
33	Marina Spasova, Dr. Senior Researcher (F)	UDE
34	Elisavet Papadopoulou, BSc Student (F)	UDE
35	Nikolaos Tetos, MSc Student (M)	UDE
36	Thomas Feggeler, PhD Student (M)	UDE
37	Jonas Wiemer, MSc Student (M)	UDE
38	Flavien Massi, Senior Consultant (M)	Intelligentsia

Annex 3

Book of Abstracts for the 2nd Training Workshop
(Side note: The BoA is mistakenly entitled "1st Training Workshop …")

1st Training Workshop & Summer School

Magnetic Nanohybrids for Cancer Therapy

within the framework of the MaNaCa Twinning|Horizon2020 project: grant agreement No 857502 (2019-2022)

BOOK OF ABSTRACTS

25-28 August 2020

Balkan Center-CIRI-AUTh, Thessaloniki-Greece

http://magnacharta.physics.auth.gr/manaca-workshop.htm

Magnetic Nanostructure Characterization: Technology & Applications

email: magnacharta@physics.auth.gr

Magna Charta

http://magnacharta.physics.auth.gr

Lab Courses

Tuesday, August 26, 2020
17^{30}-19^{30}

Lab Course 01: Young researchers: Present & Publish

M. Farle, Germany: *How to make a good scientific oral presentation*
***C. Bratsas, S. Zapounidou, Greece**: How to avoid predatory journals and plan your publication strategy*

Oral presentations at a conference or internal seminar are for sharing your research work with other scientists. They must convince the audience that the research presented is important, valid, and relevant to them. To this end, oral presentations must emphasize both the motivation for the work and the outcome of it, and they must present just enough evidence to establish the validity of this outcome. They are localized in space and time, they impose a sequence and rhythm to the audience, and they normally include some level of interaction.

Predatory publishing, sometimes called write-only publishing or deceptive publishing, is an exploitive academic publishing business model that involves charging publication fees to authors without checking articles for quality and legitimacy and without providing the other editorial and publishing services that legitimate academic journals provide, whether open access or not. They are regarded as predatory because scholars are tricked into publishing with them, although some authors may be aware that the journal is poor quality or even fraudulent. According to one study, 60% of articles published in predatory journals receive no citations over the five-year period *following publication.*

Wednesday, August 27, 2020
17^{30}-19^{30}

Lab Course 02: Young researchers: Propose & Manage

G. Brandon, Luxemburg: *H2020 MSCA Individual Fellowships for the young researchers*

What are the MSCA Individual Fellowships? Grants provided by Marie Skłodowska-Curie Actions are available for all stages of a researcher's career, irrespective of nationality. Fellows include PhD candidates and those carrying out more advanced research. Researchers working across all disciplines, from life-saving healthcare to 'blue-sky' science, are eligible for funding. Because they encourage individuals to work in other countries, the MSCA make the whole world a learning environment. They encourage collaboration and sharing of ideas between different industrial sectors and research disciplines – all to the benefit of the wider European economy. MSCA also back initiatives that break down barriers between academia, industry and business. By means of the MSCA Individual Fellowships scientists have the possibility to gain experience abroad and in the private sector, and to complete their training with competences or disciplines useful for their careers.

Thursday, August 26, 2020
17^{30}-19^{30}

Lab Course 03: Young researchers: Samples & Biomedicine

E. Myrovali & K. Kazeli, Greece: Hands on Samples for biomedical applications

Iron oxide nanoparticles (MNPs) have emerged as one of the primary nanomaterials for biomedical applications due to their long blood retention time, their biodegradability and their low toxicity. They can be used in technological applications, including clinical needs such as magnetic hyperthermia. Among the widely used synthesis routes used for synthesizing iron oxide MNPs are coprecipitation, thermal decomposition, microemulsion, and sol-gel methods. However, compared to other synthesis routes, the coprecipitation method is generally preferred due to its high yield and facile controls. More specifically, for the coprecipitation reaction, the concentration of precursors and the reaction temperature significantly affect the size, size distribution, phase and surface chemistry of resultant MNPs. First, we present the synthetic route using the aqueous chemical coprecipitation method. It has been highlighted as a cost-effective and fast process, easily expandable on an industrial level. Using the aqueous version of this method, we may avoid the use of hazardous solvents and reagents and high reaction temperatures or pressures. In that sense, aqueous coprecipitation can be considered to be eco-friendly. It is the simplest method to prepare MNPs from aqueous iron salt (Fe^{2+}, Fe^{+3}) solution. Next, we present the fabrication processes used to produce phantom with agarose solution. Gels and especially those from agarose, are routinely used as phantom models while they comprise the only transparent porous materials which successfully simulate animal tissues.

Friday, August 26, 2020
17^{30}-19^{30}

Lab Course 04: Young researchers: Magnetic Hyperthermia

A.R. Tsiapla, N. Maniotis, A. Makridis, Greece: *Hands on Magnetic Particle Hyperthermia: Experiment & Evaluation*

This Lab Course is focusing on the experiment as well as on the evaluation of Magnetic Particle Hyperthermia. After a brief introduction on the magnetic hyperthermia origin following a short presentation on the Magna Charta lab devices and equipment, the experimental process will be analyzed and presented in a real-time demonstration. Adjusted protocols and experimental strategies will be presented, targeting to the best heating results under harmless routes. Experimental part ends with the heating evaluation of the examined nanoparticle system.

Next, the computational approach of the aforementioned experiments will be presented. More specifically, recommended strategies on how to build numerical models for the description of the phenomena that take place in a Magnetic Hyperthermia *in vitro* system will be shown. In particular, we aim at the estimation of the spatial distribution of the magnetic field and the spatiotemporal temperature distribution by taking into account all the appropriate field and heat transfer boundary conditions. Moreover, we will demonstrate computationally a strategy, to mitigate eddy currents heating, by applying the external magnetic field intermittently (in an ON/OFF fashion), instead of the continuous mode typically used in Magnetic Hyperthermia studies.

Finally, a 3D-printed device for studying an alternative bio-application of applied magnetic fields on MNPs and cells, known as magnetomechanical effect, will be introduced and presented to participants.

Scope

This is the 1st training workshop combined with a summer school within the framework of the MaNaCa Twinning|Horizon2020 project (2019-2022). This workshop will focus on structural and magnetic characterization of magnetic nanohybrids and their application for cancer therapy. Aiming to establish a tradition, this workshop will provide training in the basic principles of nanomagnetism and its biomedical applicability thorough a broad series of fundamental lectures, while offering the latest insights into up-to-date aspects of magnetically driven cancer therapies.

Workshop & Summer School Program

This workshop, held in English, is addressed to Greek and foreigner graduate and PhD students, as well as to post-doc and young researchers working on the field of magnetic nanomaterials exploring their biomedical applicability. Program consists of morning and early afternoon lecture sessions. Students may hang their posters, present them by flash presentations in specific sessions and discuss their results throughout the workshop. Each afternoon, Lab courses will take place where students will receive guidelines how to present their work, apply for proposal and how to follow a rigorous protocol for sample preparation and experimental/theoretical evaluation of magnetic particle hyperthermia.

within the framework of the MaNaCa Twinning|Horizon2020 project: grant agreement No 857502 (2019-2022)

Venue

The workshop takes place at CIRI-AUTH: Center of Interdisciplinary Research and Innovation of Aristotle University of Thessaloniki.

CIRI-AUTH
Center for Interdisciplinary Research and Innovation
Aristotle University of Thessaloniki

The Center for Interdisciplinary Research and Innovation started its operation in 2014, signaling the AUTH's pursuit to redefine the role of research for the development of the country and to form new more effective interdisciplinary cooperation structures. Since 2015, and after three calls for proposals, 22 research teams have joined.
CIRI's main mission is to promote and develop interdisciplinarity in an open and collaborative environment of excellence, utilizing AUTH's research infrastructures at local, national and European level, expanding the University's synergy with society and contributing to economic and social development. of the country.

Administrative Support	Andreadou Ariadne Tel: ++302310 990580 E-mail: kedek_info@auth.gr, kedek@auth.gr
Technical Support	Kosmadakis Ioannis Tel: 2310 990587 E-mail: kedek_support@auth.gr
Address	CIRI-AUTH ΑΠΘ, Balkan Center, Builidings A & B 10th km Thessalonikis-Thermis, PO BOX 8318 Post Code 57001

ΚΕΔΕΚ
ΚΕΝΤΡΟ ΔΙΕΠΙΣΤΗΜΟΝΙΚΗΣ ΕΡΕΥΝΑΣ ΚΑΙ ΚΑΙΝΟΤΟΜΙΑΣ ΑΠΘ
http://kedek.auth.gr/

within the framework of the MaNaCa Twinning|Horizon2020 project: grant agreement No 857502 (2019-2022)

MaNaCa: Magnetic Nanohybrids for Cancer Therapy

grant agreement No 857502 (2019-2022) Projects-Twinning | Horizon 2020

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From a scientific standpoint, MaNaCa will focus on the structural and magnetic characterization of magnetic nanohybrids and their application for cancer therapy. The project's aim will be accomplished by networking IPR-NAS with two internationally-leading research organizations: the Aristotle University of Thessaloniki (AUTH) in Greece and the University of Duisburg – Essen (UDE) in Germany.

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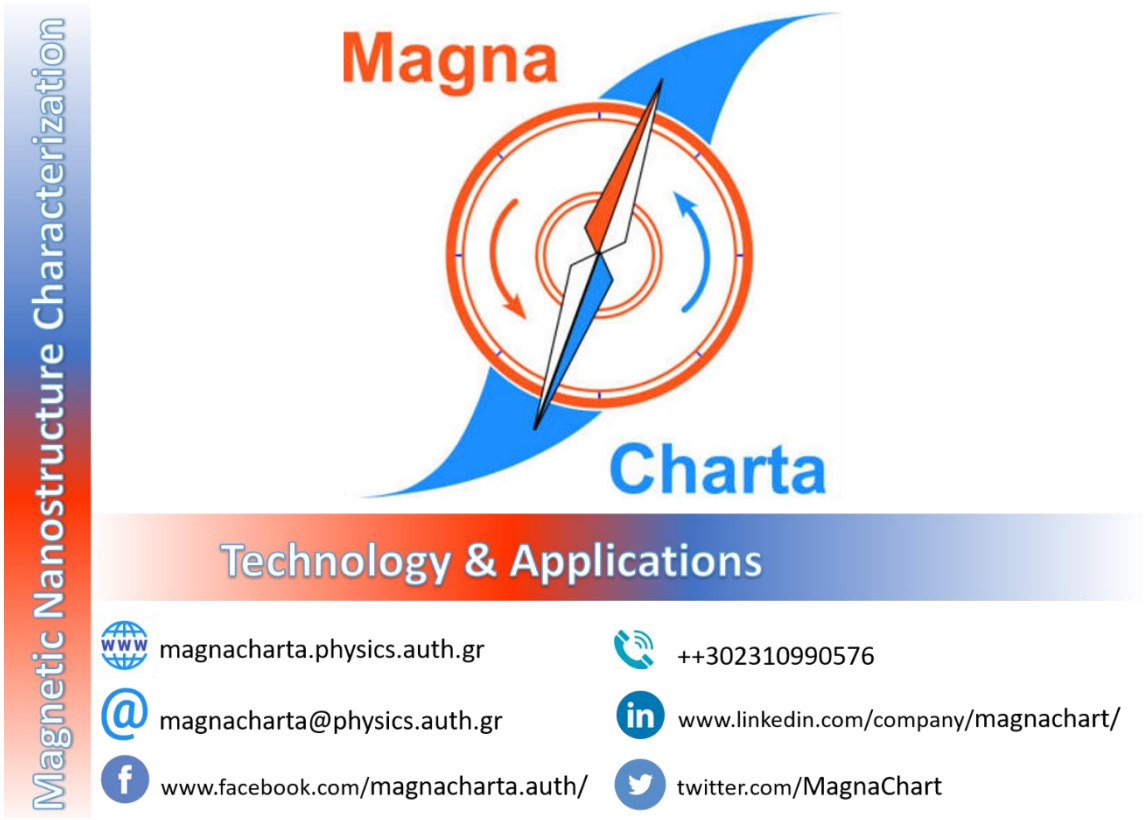
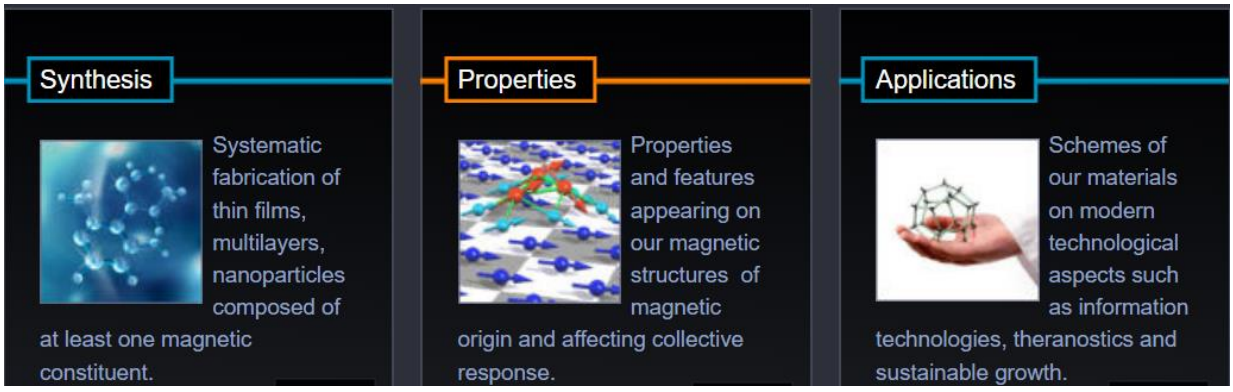


MagnaCharta group works on modern magnetic nanomaterials such as magnetic nanoparticles, multilayers and thin films. Our interests start from systematic synthesis and robust investigation of physical properties and conclude to technological applicability of nanomagnetism on diverse aspects such as information storage, biomedicine and sustainable growth.



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Oral Presentations

Num	Title & Presenting Author	Session
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O02	Iron based "Core-Shell" Nanoparticles for Magnetic Hyperthermia of Cancer Cells ***A. Manukyan, Armenia***	Materials & Structure
O03	Scaling Up Magnetic Nanoparticles Production ***K. Simeonidis, Greece***	
O04	Characterization of nanomaterials using transition electron microscopy ***M. Spasova, Germany***	
O05	Nano-Theranostics based on magnetic ferrite nanoparticles ***C. Dendrinou, Greece***	
O06	*Application of X-ray absorption fine structure spectroscopies for the study of Fe3-xMnxO4 nanoparticles* ***M. Katsikini, Greece***	Magnetism & Properties
O07	Tuning structure and Magnetic Properties of Nanoparticles for Enhanced Heating Performance ***P. Trohidou, Greece***	
O08	Basics of Magnetometry and How to Apply on Nanoparticles ***U.Wiedwald, Germany***	
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O20	The Radiobiological Basis of Radiation Therapy and Hyperthermia ***S. Spirou, Greece***	
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Magnetic Nanohybrids for Cancer Therapy

001

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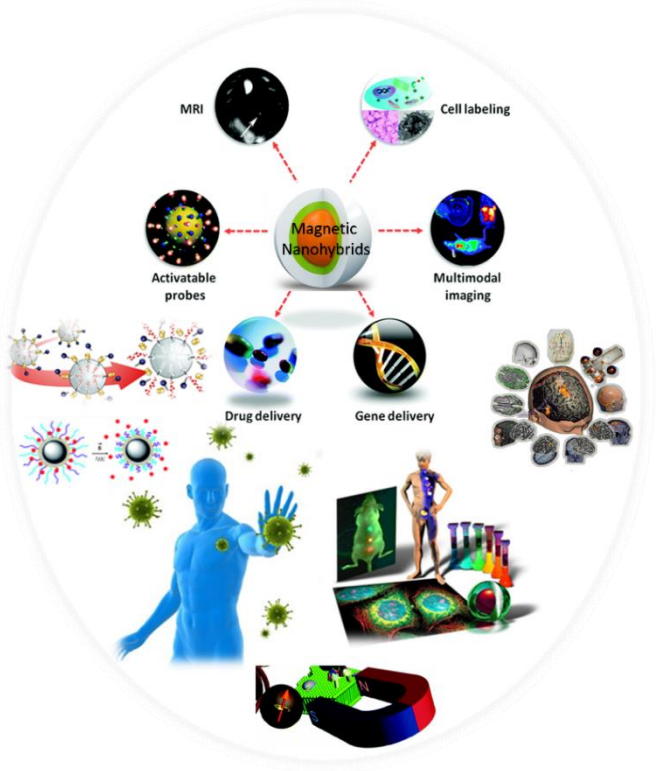
Magnetic nanohybrids may be generally classified into different types according to their morphology, intrinsic structure and composition. One finds magnetic hybrids consisting of a core/shell quasi-spherical structure with the shell (core) material either being organic or inorganic (or vice versa) in the literature.

Also, purely inorganic combinations made of ferro-, ferri-, para- and diamagnetic materials which are metallic, semiconducting or insulating have been synthesized. Also, the shape of nanoparticles can be controlled allowing the synthesis of monodisperse dumbbell-, rod-, octahedron– and disk- shaped particles. Consequently, the possibilities to design any type of magnetic nanohybrids using different synthesis routes seem boundless.



Magnetic nanohybrids based on biocompatible magnetic ferrites provide a unique toolbox for theranostics applications, since they can be remotely and non-invasively employed as smart actuators and carrier vectors. Among, their major advantages are the tunable magnetic features, the biocompatibility, the diversity of functionalization and the appropriate size scale comparable to functional biomolecules. Not only can magnetic nanohybrids be functional by themselves such as hyperthermia mediators in cancer treatment, but they can also be useful as a drug carrier and actuators for a thermally or mechanically controlled drug release. Additionally, magnetically driven mechanical forces can selectively be applied to trigger certain biological functions to determine cell growth or death.

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Iron based "Core-Shell" Nanoparticles for Magnetic Hyperthermia of Cancer Cells

O02

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Magnetic functional nanoparticles (NPs) are of great interest due to their unusual magnetic characteristics and their wide range of practical applications in advanced nanoscience, nanomaterials and nanoengineering technology, in biomedicine and so on. Nanomagnets in biomedicine used as contrast agents in magnetic resonance imaging (MRI), as magnetic agents in a targeted drug delivery, magnetic absorbers for killing cancer cells in the method of magnetic hyperthermia. Particularly important topic is the study of bi-magnetic core/shell nanoparticles, i.e., where both the core and the shell exhibit magnetic properties (ferromagnetic (FM), ferrimagnetic (FiM) or antiferromagnetic (AFM)). Such systems attract considerable attention owing to the possibility of combining materials with different magnetic properties and these combinations give rise to interface interactions such as exchange coupling, exchange bias, and proximity effects.

We focused our study on the structural and magnetic properties of carbon coated Fe/Fe3C core-shell nanoparticles, as a promising candidate for magnetic hyperthermia of cancer cells. The obtaining of the reliable structural information about the achievement of the desirable architecture (with Fe-core and Fe3C-shell) in the synthesized nanoparticles is confirmed by the methods of X-ray absorption near-edge structure (XANES), Mossbauer spectroscopy and extended X-ray absorption fine structure (EXAFS) combined with Reactive Force-Field Molecular Dynamic (MD) simulations and a magnetometry. The magnetic hysteresis loop of (Fe-Fe_3C) "core-shell" nanoparticles exhibits a demagnetization jump at low applied fields in both positive- and negative-field sweep.

This work was supported by the EC project H2020-EU.4.b. - Twinning of research institutions no. 857502 (MaNaCa).

Scaling Up Magnetic Nanoparticles Production

O03

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Among engineered inorganic nanoparticles, magnetic ones (Fe_3O_4 or γ-Fe_2O_3) represent a major class characterized by their ability to respond by various ways to the application of external magnetic fields. This response enables their localization using MRI scanners and their use as drug carriers, in magnetic separation of biomolecules using a field gradient or in heat generation or mechanical movement using an alternating magnetic field. The routes for the synthesis of such systems make full use of the manipulation of specific parameters (pH, temperature, pressure or redox potential) to generate the high supersaturation needed to nucleate the nanoparticles depending on the iron precursor. However, the production of high-quality nanoparticles rarely complies with green chemistry rules and Good Manufacture Practices strategies for clinical use such as the use of non-toxic reagents and low energy consumption. Green synthetic methods commonly refer to aqueous precipitation of iron salts with very low cost and high productivity. However, carrying out laboratory synthesis in a batch reactor involves a number of issues arising by the evolution with time of critical parameters such as the concentrations, the temperature and the pH. This is important not only for the reproducibility of the product's properties but also for the energy consumption and the dimensions of the pilot plant needed for the synthesis.

This work illustrates the production of magnetite nanoparticles by oxidative precipitation of $FeSO_4$ in aqueous media, following a continuous-flow approach which offers additional advantages. Particularly, the developed reaction setup succeeds (i) the complete separation of precursor formation from Fe_3O_4 nucleation, (ii) the achievement of constant concentrations in all ionic and solid forms throughout the production line when steady-state is reached, and (iii) the possibility to control critical parameters, such as OH^- excess, through on-line regulation of the reactor's pH. Importantly, continuous flow synthesis of Fe_3O_4 nanoparticles enables high production capacities, low energy consumption and proportional scale-up at any volume. As a proof of concept, obtained nanoparticles were evaluated according to their magnetic response as potential magnetic hyperthermia agents indicating significant improvement of heating efficiency which reaches 1.5-2 kW/g for both smaller (~40 nm) and larger (~200 nm) particle dimensions.

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Characterization of nanomaterials using transition electron microscopy

004

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Performance of nanoparticles in a broad range of application including a bio-medical is defined by their morphology, crystal structure, shape and surface features. For nanocomposite, the distribution of the elements within the particle, surface segregation resulting in formation of core-shell structure become an important question to answer. All these questions are to be addressed to Transmission Electron Microscopy, one of the most important and powerful technique for investigating the properties of nanomaterials.

In my talk I will present typical examples of FePt-Cu [1] and AgFe [2] nanoparticle studies using TEM-based techniques including imaging techniques such as high resolution TEM and scanning transmission electron microscopy (STEM) imaging, and 3D electron tomography; diffraction technique such as selected area electron diffraction; spectroscopy techniques such as X-ray energy dispersive spectroscopy (EDS), electron energy-loss spectroscopy (EELS).

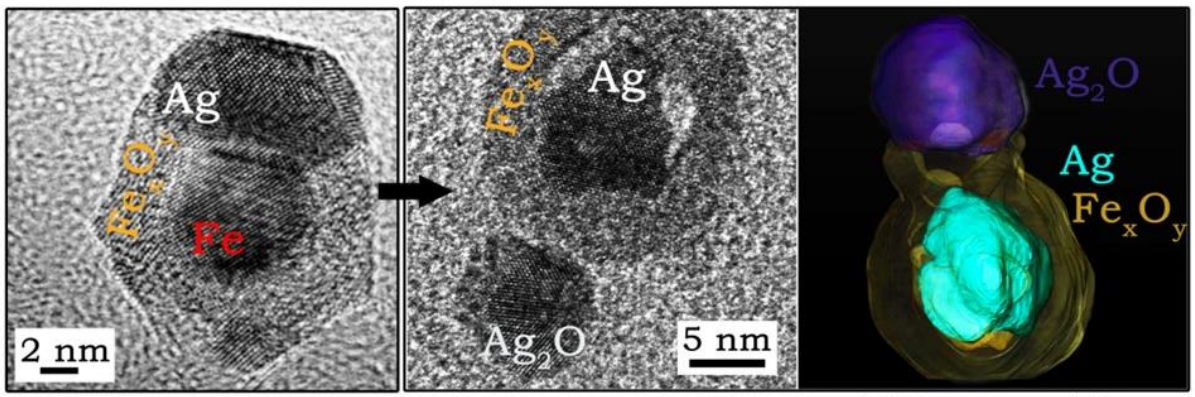

Fig. 1. HRTEM images of AgFe nanocomposite fabricated by the gas-phase condensation technique. Right image is a snapshot of element specific 3D electron tomography of AgFe nanocomposite.

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Nano-Theranostics based on magnetic ferrite nanoparticles

005

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The idea of having a "doctor" inside a body is a good metaphor for the use of magnetic nanoparticles (MNPs) in multidisciplinary medicine. Indeed, the ability to carry out diagnosis and therapy simultaneously (termed as theranostics) is gaining popularity thanks to unique features provided by nanosystems. MNPs are protagonists in various bioapplications, one of them being excellent T_2 imaging agent in magnetic resonance imaging with many in clinical trials as well as commercial products. Additionally, MNPs based drug delivery platforms have been proposed as suitable vehicles for overcoming pharmacokinetic limitations associated with conventional drug formulations.

We have undertaken a study[1-6] where we focus on synthetic parameters to control the size, composition, magnetization and colloidal stability of biocompatible coated ferrites, MFe_2O_4 (M=Mn, Co, Zn) as well as secondary magnetic nanoplatforms. Microwave assisted or conventional heating solvothermal routes were employed for the synthesis of primary MNPs while polyethylene glycol (PEG), octadecylamine (ODA), oleic acid (OA) and oleylamine (OAm) were utilized to tailor the organic surface. In that manner hydrophilic (PEG), hydrophobic (OAm), aminated (ODA) and carboxylated (OA) functionalized MNPs were fabricated. Shifting from the synthesis of primary MNPs to secondary nanostructures' complex architectures were prepared with combined functions. In specific, magnetic colloidal superparticles (MSPs) of the same and/or different hydrophobic MNPs were synthesized by multi-responsive water-soluble graft copolymers, prepared also by us, and/or sodium dodecyl sulfate. Magnetic hyperthermia study and MRI measurements proved that the designed magnetic nanopartitcles and superparticles are promising candidates for relevant theranostic treatments. Also, MNPs and MSPs served as vehicles for Non-steroidal anti-inflammatory and Alzheimer's disease drugs. By taking into account that different inflammation-related diseases require different drug administration routes, we aimed at unique release profiles. The biological behavior of the magnetic nanocarriers was evaluated *in vitro* in rat serum and *in vivo* in mice, after radiolabeling with a γ-emitting radionuclide, ^{99m}Tc.

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Application of X-ray absorption fine structure spectroscopies for the study of $Fe_{3-x}Mn_xO_4$ nanoparticles

O06

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X-ray absorption fine structure (XAFS) spectroscopy is a well suited technique for the study of magnetic nanoparticles. It is commonly applied in Synchrotron Radiation Facilities because it necessitates a broad energy range. XAFS spectroscopy is element specific and does not require long range periodicity. The spectrum is divided in two parts, the part close to the absorption edge that is called X-ray Near Edge Structure (XANES) and provides information on the oxidation state and the site occupation of the absorbing atom (e.g. tetrahedral or octahedral). The part of the spectrum that extends at higher energies is called Extended XAFS (EXAFS) and provides bonding configuration of the metal (nearest neighbor distances and coordination numbers). After a brief introduction on the XAFS spectroscopies, examples of the analysis of magnetite and manganese ferrite nanoparticles will be given. XAFS spectra recorded at the K and $L_{2,3}$ absorption edges of Fe and Mn will be discussed.

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Tuning structure and Magnetic Properties of Nanoparticles for Enhanced Heating Performance

O07

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Magnetic Nanoparticles are gaining increasing interest in biomedicine due to their applications in diagnosis and therapy. Interestingly, the advances in nanotechnology have led to the very good control of both their growth parameters and their morphology, allowing the synthesis of magnetic nanoparticles with well-defined characteristics. Therefore, the research interest is now focusing on the study of new nanoparticle structures with enhanced performance in biomedical applications.

In view of this, we have developed a model to study the magnetic behavior and to investigate the mechanism of magnetic heating due to susceptibility losses in complex nanoparticles with core/shell (or surface) morphology, using the Monte Carlo simulation technique with the implementation of the Metropolis algorithm. Two examples of these magnetic nanoparticle systems will illustrate the improved performance when magnetically-mediated heating is used for cancer treatment.

We first investigate the magnetic behavior and the heating mechanism in a complex Fe/Fe-oxide nanoparticle. Our calculation shows that the enhanced core magnetization and the anisotropy enhancement in these complex structures result for all the sizes and shapes to higher specific absorption rate (SAR) values than the pure iron-oxide ones [1]. Maximum SAR value is obtained for the truncated cuboctahedral shape of the nanoparticles. Our results are compared and they are in good agreement with experimental finding.

The other study is on an Fe oxide nanoparticle (based on the magnetite (Fe_3O_4) bulk structure) with structural defects. Our calculations demonstrated [2] that the local symmetry breaking due to the atomic scale defects in the Fe3O4 structure is responsible for the enhancement of their magnetic anisotropy. The defects act as pinning centers and result to a competition amongst the magnetic moments that causes a non - coherent reversal and consequently a delay in the relaxation of the spins. Our calculations have shown that these nanoparticles can have a ten-fold rise of their heating performance, as compared to that obtained by the defect-free nanoparticles.

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Basics of Magnetometry and How to Apply on Nanoparticles

008

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Magnetometry is the major tool for the magnetic characterization of nanoparticles. In this talk, I am presenting the fundamentals of magnetometry and show how such concepts are nowadays used in state-of-the-art magnetometers. Fig. 1 presents a photograph of a Physical Property Measurement System (PPMS) equipped with a Vibrating Sample Magnetometer (VSM) and magnetic data of $MnFe_2O_4$ and $CoFe_2O_4$ nanoparticles before and after covering with a Fe_3O_4 shell. These particles were optimized for high specific loss power (SLP) in magnetic particle hyperthermia [1]. Problems, artefacts and sensitivity concerns in magnetometry are discussed in detail. Based on this, the best experimental approach can be chosen to address the nanoparticle magnetism. Several examples including extremely diluted systems are presented where specific protocols of sample preparation were chosen to optimize magnetometry results [2-6].

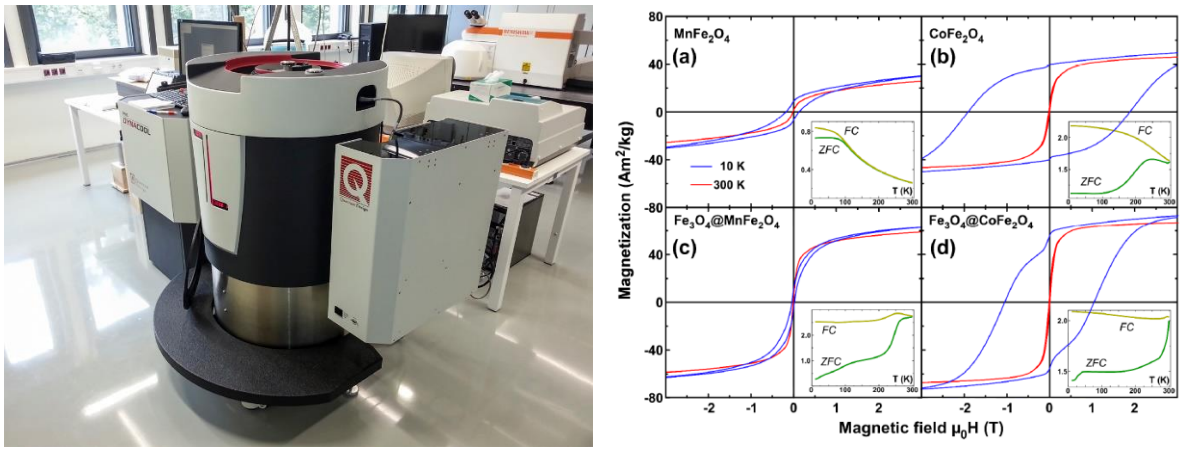

Fig. 1: PPMS DynaCool at the University of Duisburg-Essen and magnetic data of $MnFe_2O_4$ and $CoFe_2O_4$ nanoparticles before and after covering with a Fe_3O_4 shell [1].

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Introduction to X-Ray Magnetic Circular Dichroism

009

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The direction and the size of magnetic moments in materials exhibiting a unidirectional spin alignment can be measured by the X-ray Magnetic Circular Dichroism effect (XMCD) [1]. By setting the energy of the circularly polarized X-rays to an X-ray absorption edge of the investigated material the element-specificity is realized, exciting electrons from core energy levels to empty states above the Fermi energy. Using sum rules the orbital and spin moments can be determined from XMCD measurements [1].

In the talk the physical background of the XMCD effect and the sum rules will be elucidated. This is followed by an overview on the spatially-resolved XMCD technique of Scanning Transmission X-ray Microscopy detected Ferromagnetic Resonance (STXM-FMR), which offers spatially-resolved (< 50 nm) measurements of dynamic magnetization excitations up to 10 GHz) [2-4].

Research performed in collaboration with R. Meckenstock, D. Spoddig, B. Zingsem, H. Ohldag H. Wende, M. Farle, M. Winklhofer and K. Ollefs.

Financial support: FWF Project No. I-3050, ORD-49 and DFG Project No. 321560838.

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Core-Shell and Bi-phasic Magnetic nanoparticles for cancer therapy: Structure and properties

O10

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Progress in techniques for fabrication of magnetic nanoparticles (MNPs) has enabled the development of methods for synthesis of new types of MNPs, as core/shell (C/S) and Bi-phase (BP). CS MNP consists of an inner core which made of a one material coated with another material as an external shell. So, in the case of CS MNP it is possible to combine materials with a high magnetic moment as core (for ex. Iron or others) and a shell with good biocompatibility (for ex. iron oxide or others). BP MNP consists of two magnetic materials with opposite magnetic properties, for ex. hard (spinels ferrites, hexaferrites) and soft (manganites) magnets, magnetic materials (with high magnetic parameters) and biocompatible (for ex. Hydroxyapatite or other) magnetic and ferroelectric materials. The main advantage of such MNP is their polyfunctionality, as well as the possibility of optimizing the target physicochemical properties of the core material. Advances in nanotechnology make it possible to fabricate multifunctional MNPs for theranostics - applications of MNPs from visualization to drug delivery and therapy simultaneously.

The main attention in the study of such particles is given to studying the dependence of their properties on the synthesis technology and particle size, while the phase state and magnetic structure significantly affect the properties of CS and BP MNP.

The present report is focused on the studying of magnetic structure, the phase composition of CS and BP MNP and their influence on the properties of such particles. The main attention is paid to the use of Mössbauer spectroscopy (MS), because MS has a unique sensitivity that is inaccessible to other methods. Thus, the Mössbauer spectroscopy is a highly efficient method of studying the phase states, the magnetic structure as of the surface layer or shell, as well as the core of MNPs.

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Ferromagnetic Resonance: Theory and Applications for Magnetic Nanoparticles

011

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Ferromagnetic resonance (FMR) is a spectroscopy technique for an in-depth investigation of the magnetic properties of nanomaterials. It is based on the detection of magnetization precession via the measurement of microwave absorption (usually in GHz range) as a function of external field/frequency [1]. The resonance conditions in ferromagnetic materials are determined by the contributions of shape anisotropy (defined by the demagnetizing factor), magnetocrystalline anisotropy, strength and direction of the applied DC magnetic field in combination with a frequency of RF microwaves. Thus, FMR spectroscopy is a primary tool for analysis of magnetic anisotropy contributions and g-factors of magnetic materials. The frequency-dependent spectrum linewidth provides an information about relaxation processes in ferromagnets and Gilbert damping. For ensembles of magnetic nanoparticles, FMR spectroscopy is utilized for studying the variation of magnetic anisotropy, superparamagnetic behavior [2], temperature-dependent relaxation times [3], surface effects [4], chain configurations due to dipole-dipole interaction [5].

In the talk, the theoretical background of FMR will be introduced with the focus of Smit-Beljers approach, and the common measurement techniques will be overviewed. The FMR studies will be illustrated with examples of magnetic nanoparticles for biomedical applications including cancer hyperthermia [6].

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Magnetic liposomes as versatile clinical carriers

O12

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Liposomes are spherical vesicles formed by an amphiphilic lipid bilayer membrane, similar to the cell membrane. They can be unilamellar or multilamellar, with negative, positive or neutral surface charge and size ranging from 100 nm to several μm.
Due to the amphiphilic character of lipids as e.g. phospholipids, with hydrophilic head and hydrophobic tail, they self-assemble in an aqueous medium and separate the inner core from the exterior by a fatty layer. This structure allows for the incorporation at the same time of substances (proteins, enzymes, drugs) that are hydrophilic (in the aqueous core) and hydrophobic (inside the lipid bilayer), constituting a versatile clinical carrier. Especially for hydrophobic materials, encapsulation in liposomes increases their solubility and bioavailabilty.

Various preparation techniques have been examined to optimize their physicochemical and colloidal characteristics, such as loading efficiency, size distribution and long-term stability that affect critically the biological interactions with the cells.
Surface modification by peptides or other ligands offers additional functionalities that facilitate drug targeting and delivery and improve further pharmacokinetics and biodistribution.

We have encapsulated in magnetic liposomes novel hybrid ternary vanadium-curcumin complexes, and demonstrated enhanced solubility and bioavailability, low toxicity, high stability, anti-oxidant activity and DNA binding by intercalation [1]. Several novel metal-flavonoid complexes with anti-oxidant and anticancer activity are also examined to explore their therapeutic potential [2,3].

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Magnetite-Gold nanohybrids as ideal platforms for theranostics

013

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In this work, we present the first size-dependent study of hybrid Fe_3O_4-Au NPs with diameters of 6-44 nm Fe_3O_4 and 3-11 nm Au for theranostics combining the contrast enhancement in magnetic resonance imaging (MRI), the heating potential in magnetic particle hyperthermia (MPH) and dual chemical functionality for the payload delivery.

High-quality Fe_3O_4 nanocrystals with bulk-like magnetic behaviour were obtained as confirmed by the presence of the Verwey transition. The 25 nm-sized octahedral Fe_3O_4–Au hybrids showed the best characteristics for MRI and MPH. We obtained an extraordinarily high r_2-relaxivity of 495 $mM^{-1}{\cdot}s^{-1}$ along with a specific loss power of 617 $W{\cdot}g_{Fe}^{-1}$. The functional *in vitro* hyperthermia test for the 4T1 mouse breast cancer cell line demonstrated 80% and 100% cell death for immediate exposure and after precultivation of the cells for 6 h with 25 nm Fe_3O_4–Au hybrid nanomaterials, respectively [1].

As a next step, Fe_3O_4-Au hybrids were conjugated with two fluorescent dyes or the combination of drug and dye allowing the simultaneous tracking of the nanoparticle vehicle and the drug cargo *in vitro* and *in vivo*. The delivery to tumors and payload release were demonstrated in real time by intravital microscopy [2]. Replacing the dyes by cell-specific molecules and drugs makes the Fe_3O_4-Au hybrids a unique all-in-one platform for theranostics.

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The Blood-Brain-Barrier as target for magnetic nanoparticle imaging and opening

014

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Blood vessels in the brain are made up, contrary to all their cousins in the body, from three layers of cells: Tightly connected inner Endothel cells forming the lumen are supported by Pericytes, which in turn are in close contact with dendritic foot plates from Astrocytes. This complex structure limits as gate keeper effectively any access to the brain parenchyma. It is called the blood-brain-barrier (BBB) and builds a formidable obstacle for most substances except a few lipophilic or highly needed ones like glucose. Clearly the BBB thus is a major obstacle for drug delivery to the brain as would be needed to treat against brain tumors. However, it was observed that the BBB can be opened generally by chemical means, but more localized by soft hypothermia as well. We were able to prove localized BBB opening by IR laser illumination even through a rat's skull and are now trying to perform the same feat by localized heating of SPIO nanoparticles inside an MPI scanner. Above all, safe and reversible BBB opening has to be established to allow otherwise effective cytostatics to permeate the brain in the vicinity of a tumor. My talk will present the project's current state with respect to Magnetic Particles Imaging and Laser-heating.

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Cancer nanomedicine: considerations for the *in vitro* experimental design

015

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Cancer nanomedicine harnesses the unique properties of nanomaterials, in order to develop novel technologies and tools in the challenging field of cancer research. Nanomaterials, being multifunctional and diverse, are currently being used for the development of novel methods in tumor targeting, drug delivery, gene silencing, in phototherapy, cancer radiotherapy, and for the development of novel diagnostic/imaging assays. Clinical translation of emerging technologies though, requires overcoming the critical hurdles that stem from the complex interactions between nano-objects and biological systems. Noteworthy, the *in vitro* cell culture assays that are commonly used in cancer research, have been developed and optimized for the evaluation of chemical compounds. Nanoparticles, due to their size and their optical and physicochemical properties, tend to interfere with these assays in various manners, leading often to misinterpretation of the observed effects which is reflected in the lack of comparability of the results between laboratories.

In order to overcome these complicacies, standardized protocols/guidelines for the *in vitro* assessment of novel nanobiotechnological approaches should be developed by defining and reporting the specific interference-causing experimental parameters. Significantly, the potential source of interference could be determined by the employment of various alternative assays examining the same effect. Moreover, the *in vitro* model system should be chosen considering the nano-object's introduction route in the organism along with the exposure site. Appropriate and biologically realistic nanoparticle concentrations should be examined. Nanomaterial formulations should be characterized not only in their solid state but after their exposure in biological environments as well. Finally, researchers should conduct their experiments in various experimental settings (e.g. use of FBS-enriched medium or not, different cellular proliferation states) with all the relevant controls and report all of their findings.

It has become evident, that nanomedicine has the potential to revolutionize the fight against cancer. However, in order to generate accurate and reproducible data and accelerate clinical translation, standardized optimized methodologies should be adjusted for the study of nanomaterials. Only by employing multiple methods and optimizing existing assays while openly discussing in the literature the relevant complications and troubleshooting of research protocols, researchers will be able to understand, identify, and control the factors that affect biological responses to nanomaterial-based technologies, and thus develop and use standardized protocols to generate robust and reliable data that will enable clinical translation of their findings.

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How cells respond to magnetic field?

Magnetic hyperthermia for cancer treatment

016

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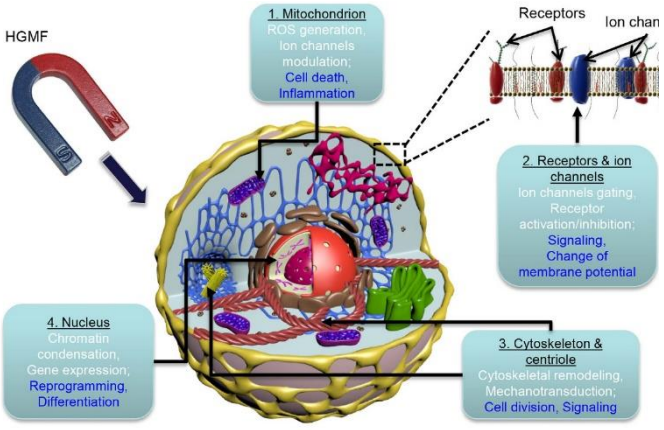
Due to their size-tunable physical and chemical properties, magnetic nanoparticles have demonstrated a wide range of applications ranging from medical diagnosis to treatment. Combining a high saturation magnetization with a properly functionalized surface, magnetic nanoparticles are provided with enhanced functionality that allows them to selectively attach to target cells or tissues and play their therapeutic role in them. In particular, iron oxide nanoparticles are being actively investigated to achieve highly efficient carcinogenic cell destruction through magnetic hyperthermia treatments. Magnetic hyperthermia induces local heat when a radiofrequency magnetic field is applied, provoking a temperature increase in those tissues and organs where the tumoral cells are present.

This presentation examines some of the important biological changes in cancer cells observed after magnetic hyperthermia, which are ultimately related to cancer cell death. Among them cytoskeleton remodeling, oxidative stress and expression of heat shock proteins are the important cellular alterations leading to apoptosis.



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Enhancing Cancer Immunotherapy through Nanotechnology

017

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Cancer Immunotherapy orchestrates the immune system of the human body to attack cancer cells. Despite the great success of cancer immunotherapies in clinical settings in recent years, major bottlenecks are toxicities arising from dose-limit as well as low rates of patient responses. Recent developments in the field of Nanotechnology and Bioengineering offer new approaches and unique modes of action of nanomedicines that can dramatically improve not only the safety but also the efficacy of Cancer immunotherapy. Localized immunotherapy with nanomedicines that accumulate within tumours via the enhanced permeation and retention effect, reduces systemic toxicity and improves the window of action of potent immunostimulatory molecules while still promoting systemic antitumor immunity. Cancer nanomedicine provides a robust and versatile platform to deliver combination therapies to enhance the activities of immune effector cells while inhibit the function of immune suppressor cells.

It is well documented that certain tumors develop adaptive and acquired mechanisms of resistance, rendering them moderately responsive to immunotherapies. Nanomedicine has the potential to enhance cancer immunotherapies in diverse ways, and provides solutions with significant impact on clinical translation. For example, nanoparticles can be designed to interact with external energy sources, such as magnetic fields (hyperthermia), to enhance immunogenic cell death, promoting thereby a cytotoxic T cell-mediated immune response. Moreover, nanomedicines can be designed to facilitate anti-tumor immune responses to overcome the immunosuppressive microenvironment.

Because the components of the immune system act in a highly dynamic network, effective stimulation of a small number of immune cells (leucocytes) in tumors or lymphoid organs through nanotechnology can lead to alterations in the tumor microenvironment driven by cell-to-cell communication. The design of next-generation immunotherapeutic nanoparticle formulations is expected to involve stimulation of both innate and adaptive immunity, through a) enhanced recognition of cancer cells by antigen-presenting cells, b) enhanced T cell activation, c) reduced immune-suppressive signaling, and d) engineering antigen-presenting cells/dendritic cells to specifically express tumor antigens.

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Magnetic nanoparticles for cancer therapy and diagnostics: effects of morphology and coating

O18

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Nowadays, magnetic nanoparticles (MNPs) are intensively studied as a perspective tool for cancer therapy and diagnostics. Unique combination of the magnetic and surface properties of MNPs in a combination with iron biocompatibility allows using them as contrast agents for MRI, drug delivery, magnetic separation, magnetic hyperthermia and many others. Our work is concentrated on chemical design of MNPs and optimization of their properties for cancer therapy and diagnostics.

Almost all properties of MNPs are strongly dependent on their size, shape and structure. We have developed the methods of the synthesis of MNPs with defined shape (spheres, cubes, clusters, rods) and size and also evaluated the effect of these parameters on MNPs effectiveness in cancer theranostics.

We have proposed the human serum albumin (HSA) coated MNPs as a promising system for drug delivery. HSA is a natural transport protein for xenobiotics in the blood and can effectively bind drug molecules to the surface. Physicochemical properties of HSA-MNPs were investigated in details by HAADF-TEM, DLS, AFM, and also magnetization and T2-relaxation properties were evaluated. It was shown that the HSA coating is able to delivery different drug molecules, such as doxorubucin, cisplatin and bacteriochlorine a, whereas a magnetic core allows real-time imaging by MRI. Particularly for doxorubicin loaded MNPs we have shown the effective imaging of 4T1 mouse breast cancer model accompanied with increase of median survival from 26 to 39 days. These results allow to propose HSA coated MNPs as a perspective tool for drug delivery of different antitumor drugs for cancer treatment.

Another important approach for cancer treatment is a magnetic hyperthermia. This strategy is based on ability of MNPs absorb electromagnetic radiation and convert it in to heat that can locally kill tumor cells. One of the main parameters of MNPs for successful application in hyperthermia is Specific Absorption Rate (SAR). However, a small size and superparamagnetic behavior of HSA-coated MNPs do not allow to use them for magnetic hyperthermia. We have shown that anisotropic nanoparticles with a diameter of more than 15 nm, such as cubes and rods show much higher SAR values in comparison with spherical. Another approach is to use magnetic materials with a higher coercivity such as cobalt ferrite. Such MNPs can be efficient tool for tumor heating leading to elimination of 80% of tumors with full remission in animal experiments. Thus, we were able to show that by tuning of nanoparticles morphology and structure it is possible to use them in different approaches for cancer treatment.

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Cell membrane-coated magnetic nanocubes for the treatment of glioblastoma

019

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Glioblastoma multiforme (GBM) is a malignant tumor of the brain with high percentages of mortality and morbidity worldwide. As in most cancers, the conventional treatments consist of surgery and adjuvant chemo- and radio- therapy, which unfortunately are proven insufficient for numerous patients. An alternative way of treatment is the use hybrid nanosystems able to safely deliver the desired drugs across the blood-brain barrier and release their cargo upon specific stimuli. In this study, we hypothesized that the use of sorafenib (SOR)-loaded hybrid nanoparticles consisting of a magnetic core (Fe_3O_4) and an antioxidant (MnO_2) shell and coated with a cell membrane (derived from U251 glioblastoma cells) (CM-NCubes), could represent a novel system with an inherent targeting ability that can effectively treat GBM.

The fabricated CM-NCubes have a diameter of about 25nm and present excellent colloidal stability in various media. The MnO_2 component of the CM-NCubes have the ability to generate oxygen after reacting with H_2O_2, while the Fe_3O_4 component is responsible for the increase of temperature above 42°C in only a few minutes. The CM-NCubes present a better internalization by the U251 cells in contrast to lipid coated NPs that were used as a negative control. Finally, the combination of hyperthermia and the drug SOR was more effective on killing GBM cells compared to hyperthermia or SOR alone.

The CM-NCubes, can be potentially used for imaging, guided delivery and controlled release due to their Fe_3O_4 component, while the MnO_2 component can act as a hypoxia mediator that enhances the effect of chemotherapeutic agents like SOR. The CM coating enhances their biocompatibility as well as their uptake by GBM cells demonstrating an inherent targeting ability without further functionalization.

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The Radiobiological Basis of Radiation Therapy and Hyperthermia

O20

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Radiation Therapy (RT), surgery and chemotherapy are the main treatment approaches for cancer. In addition, RT is used to treat certain forms of benign disease, such as arteriovenous malformations, acoustic neuroma etc. Rapid progress during the past 30 years has transformed RT and significantly enhanced its value as a treatment modality. Still, a lot can potentially be gained by combining RT with other techniques, such as Hyperthermia.

In this presentation we will:

a) Introduce Radiation Therapy, including its characteristics, types and equipment used

b) Describe the radiobiology of the interaction between RT and cells

c) Introduce Hyperthermia, including its cellular effects

d) Present the synergy between RT and Hyperthermia

e) Present the results of clinical trials, using both traditional Hyperthermia techniques and Magnetic Nanoparticles

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Magnetic Particle Imaging Applications in Cancer Inflammation, Theranostics, and Cell Tracking

021

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Advances in cancer immunotherapy have fueled a boom in immuno-oncology research. There is an urgent need to track and accurately quantify cells in vivo. In addition, researchers need a method to systematically measure the biodistribution of immune cells in solid tumors over time.

Magnetic Particle Imaging (MPI) is a novel preclinical imaging technique used to non-invasively track iron-oxide-tagged immune cells ***in vivo*.**

MPI can be used to track *in vivo* the biodistributions of macrophages, T-cells, stem cells or tumor cells for several days. The data is specific and quantitative. MPI can also be applied to drug delivery monitoring and image-guided theranostics. Data acquisition from nanoparticles can be combined with MRI or CT. Researchers can generate localized hyperthermia zones, for nanoparticle actuation and tumor immunogenesis as an adjunct to radiation or immune therapies. Results from immune cell tracking, *in vivo* quantitation, drug-delivery monitoring and localized hyperthermia will be discussed.

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Combinatory, Magnetic or Non-magnetic cancer modalities?

O22

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Effective cancer therapy is one of the grand challenges of the 21st century. Advances in improving the efficacy and reliability of the present-day cancer therapies will not only translate into a broad scale sociologic impact but also generate vast economic benefits. Besides the most familiar present-day cancer therapies, i.e. radiotherapy and chemotherapy, magnetically stimulated hyperthermia of tumor tissue has evolved into an approved therapy for cancer complementing or even competing with the chemotoxic and radiological approaches. It is generally understood as a local (cellular) temperature increase in malignant cells to achieve selective damage of tumor tissue and the biochemical pathways causing the spreading of tumor.

Despite this broad knowledge base the challenge remains to control the spatial extent of the heating – ideally to the malignant cell or - even smaller - to a pathway in the metabolism of the cell and combine magnetic particle hyperthermia with current standard cancer modalities. In order to promote a successful combinatory cancer scheme with or without magnetic driven probes certain issues have to be tackled:

1. the safe, comfortable, reliable, reproducible and quantifiable intratumoural injection of the entity probes to the tumor region,
2. the visualization and in vivo monitoring of the probe accumulation,
3. the optimization of the probes capable of reaching and maintaining therapeutic temperatures inside malignant cells.
4. non-invasive diagnostics capable of monitoring heat distributions within tumors and healthy tissue.

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Poster Presentations

Num	Title & Presenting Author
P01	Regional Focus effect on Magnetic Particle Hyperthermia ***E. Myrovali**, MagnaCharta, CIRI-AUTH, Thessaloniki Greece*
P02	Combinatory magnetothermal and magnetomechanical stress on human breast cell lines ***A. R. Tsiapla**, MagnaCharta, CIRI-AUTH, Thessaloniki Greece*
P03	In vitro response of normal and cancerous cell lines under magneto-mechanical activation ***A. R. Tsiapla**, MagnaCharta, CIRI-AUTH, Thessaloniki Greece*
P04	In vitro and in vivo study of magnetic nanoparticles with potential for anti-tumor therapy ***V. Uzunova**, Institute of Biophysics and Biomedical Engineering, BAS, 1113 Sofia, Bulgaria*
P05	Synthesis and Characterization of MagnetoElectric $BiFeO_3$ nanoparticles ***K. Papadopoulos**, MagnaCharta, CIRI-AUTH, Thessaloniki Greece*
P06	Synthesis and characterisation of magnetic bio ceramics nanoparticles for medical applications ***K. Kazeli***, International Hellenic University, Thessaloniki, Greece
P07	Oxidative stress analysis, haemolytic activity and cytotoxicity of bioactive glass-ceramics nanomaterials, ***K. Kazeli***, International Hellenic University, Thessaloniki, Greece
P08	Fe-Fe_3O_4 "Core-Shell" Nanoparticles: Synthesis and Characterization ***G. Chilingaryan***, *Institute for Physical Research, National Academy of Sciences of Armenia, Ashtarak, Armenia*
P09	Fe-Fe_3C "Core-Shell" Nanoparticles: Synthesis and Characterization, ***H. Gyulasaryan***, *Institute for Physical Research, National Academy of Sciences of Armenia, Ashtarak, Armenia*
P10	Novel tissue engineering scaffolds and liposomal formulations loaded with Alkannins/Shikonins for dermal applications ***A. S. Arampatzis, A. E. Koletti,** Chemical Engineering Department, Aristotle University, Thessaloniki-Greece*
P11	An NMR and LC-MS based metabolomics approach to elucidate the mechanism of action of alkannin and shikonin on breast cancer cell line MCF-7 ***A. Nakas**, Chemical Engineering Department, Aristotle University, Thessaloniki-Greece*
P12	Nanostructured permanent magnets: Materials, geopolitical prospects, future challenges & recycling, ***G. Sempros**, School of Physics, Aristotle University of Thessaloniki-Greece*
P13	Superparamagnetic Splenic Macrophages: Magnetic Characterization and Investigation of Immune Response by Low-frequency Magnetic Stimulation, ***N. Tetos**, Fakultät für Physik, Universität Duisburg-Essen-Germany*
P14	Revolutionary green perovskite or perovskite-like solar cells ***L. Theofylaktos**, NCSR Demokritos, Athens-Greece*
P15	Blood cancer: New insights of Oxidative stress in carcinogenesis ***I. Tsamesidis**, Université de Toulouse, IRD, UPS, Toulouse, 31400, France*
P16	Design and construction of 3D-printed magnetic tools for biomedical applications ***P. Kyriazolopoulos**, MagnaCharta, CIRI-AUTH, Thessaloniki-Greece*
P17	CoCrFeMnNi High Entropy Alloy Nanoparticles from the gas phase ***I. N. Sahin**, Fakultät für Physik, Universität Duisburg-Essen-Germany*
P18	Standardizing magnetic hyperthermia experiment: a protocol for a reliable measurement ***A. Makridis,** MagnaCharta, CIRI-AUTH, Thessaloniki Greece*
P19	A Multiphysics Model for the Hyperthermia Treatment of Residual Bone Tumors Cells Using Magnetic Scaffolds, ***M. B. Lodi**,* Dept. Electr. & Electron. Engin. University of Cagliari, Cagliari Italy
P20	X-ray spectroscopic study of magnetic ferrite nanoparticles for theranostic applications: effect of size and distribution, ***F. Pinakidou**, School of Physics, Aristotle University of Thessaloniki-Greece*
P21	Estimating the effective anisotropy of ferromagnetic nanoparticles through magnetic and calorimetric simulations, ***N. Maniotis,** MagnaCharta, CIRI-AUTH, Thessaloniki Greece*
P22	Nanoimprint Defined Magnetic Nanoplatelets for Cancer Treatment and Biomedicine ***J. Li**, Department of Applied Physics, Eindhoven University of Technology-Netherlands*
P23	Magnetic characterization of Fe/Fe_3C nanoparticles fabricated by solid state pyrolysis ***E. Papadopoulou**, Fakultät für Physik, Universität Duisburg-Essen-Germany*

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Regional Focus effect on Magnetic Particle Hyperthermia

P01

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Magnetic nanoparticles (MNPs) may be used as diagnostic and therapeutic agents due to their low cost and tunable properties. Various types of heat treatment modalities are available for cancer treatment, such as microwaves, radio frequency, focused ultrasound, hyperthermia and magnetic hyperthermia. Materials' research on magnetic hyperthermia agents, focuses on iron oxide nanoparticles because they are biocompatible and they follow a well-known metabolic pathway in the human body. Moreover, they may be used in multifunctional aspects (i.e. MRI contrast agents, drug-carriers). MNPs create localized heat, when subjected to an alternating current magnetic field, because of hysteresis and/or relaxational losses. This heat can be used for therapeutic hyperthermia treatment of diseased cancer cells. However, previous study has shown that a typical problem of the application of hyperthermia is the difficulty to localize the heat without damaging potentially healthy surrounding tissues.

The purpose of this study is how to avoid unnecessary heating of healthy tissues during a hyperthermia protocol, incorporating an additional set-up of a static magnetic field. A system of commercial magnets (setups of two or four) results to a static magnetic field map where a field free region (FFR) may occur with respect to constituent magnets' number, intensity and orientation. Within this region, MNPs experience solely the AC hyperthermia, resulting to AC heating. On the contrary, outside this FFR region, MNPs driven by the static field, reach saturation while alternating magnetic field can no longer rotate their magnetization, thus AC heating appears suppressed. Thus, regional focus of magnetic hyperthermia application may be achieved to selected "malignant" areas. This is directly exploitable in making magnetic hyperthermia a more effective approach for cancer therapy by decreasing the possibility of side-effect heating of surrounding healthy tissues.

As a proof of concept, obtained iron oxides nanoparticles (10, 40 and 80nm) were evaluated according to their magnetic response as potential magnetic hyperthermia agents indicating significant improvement of heating efficiency in free region (FFR) which reaches ~100, 300 and 600W/g for 10, 40 and 80nm particle dimension at frequency 765kHz and applied magnetic field 30mT. Our results demonstrate that it is possible to spatially control the temperature rise in magnetic particle hyperthermia using the proposed approach.

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Combinatory magnetothermal and magnetomechanical stress on human breast cell lines

P02

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Cancer is one the largest cause of death globally after cardiovascular diseases. Magnetic nanoparticle hyperthermia, magnetomechanical stress and especially the combination of these two techniques is a very promising cancer treatment. In the first technique, an external alternating magnetic field is used to heat the area of the cancerous tissue up to 41-45°C, due to the local heating of the magnetic nanoparticles (MNPs) which finally leads to cell apoptosis [1]. In the second technique, magnetic field exerts magnetic forces on the MNP which in turn exerts mechanical forces on malignant and non-malignant cell membranes, causing damage only to cancerous tissues [2].

This study highlights the differences obtained in sensitivity of breast cancer cells (MCF-7) and non-cancerous (MCF-10A) cells not only to a combined treatment of magnetic hyperthermia (HP) and pulsed magnetic field (PMF) in presence of iron oxide MNPs, but also to each treatment separately. MNPs exhibited excellent biocompatibility and allowed cell proliferation. MTT data showed high cell viability (between 80-100%) of non-cancerous cells after the following treatments: PMF+MNPs, HP+MNPs and HP+PMF+MNPs. It is worth noting that no morphological changes in these cells were observed. On the contrary, MCF-7 showed higher sensitivity after treatment with PMF+MNPs, HP+MNPs and HP+Pulsed+MNPs. PMF+MNPs induced a time-dependent reduction of viable cells and after 5 days of incubation, viability decreased to 50%. The greatest effect on cell viability suppression was observed after treatment with HP+PMF in presence of MNPs, where the cell viability was <50%. The morphology of these cells was changed and more rounded, especially after 5 days of treatment with HP+PMF+MNPs. Although the above combined treatment caused decreased viability of breast cancer cells, the non-cancerous cells retained a high post-treatment cell viability revealing the potential use of the above combined treatment in anti-tumor therapy with low side effects on normal cells.

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In vitro response of normal and cancerous cell lines under magneto-mechanical activation

P03

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The magneto-mechanical effect, that is the exercise of mechanical forces through magnetic fields, has been the subject of much attention and study in recent years. The combination of alternating, static or rotating magnetic field configurations with magnetic nanoparticles (MNPs) allows them to bind with malignant cells and lead them to cellular damage via magneto-mechanical stress, making the MNPs useful in biomedical research [1].

In this work, iron oxides MNPs (Fe_3O_4) with a hydrodynamic diameter of 100 nm were used and the proliferation rate of multinucleated cancer (MCF-7, MDA-MB-231) and non-cancer (MCF-10A) cells were investigated in three different types of magnetic fields: static, rotating and pulsed field mode for up to five days. In both cancer cell lines pulsed field mode was the optimum magnetic field which caused a large decrease in cells' viability (below 40% and 45% in MCF-7 and MDA-MB-231, respectively), while static and rotating kept the viability at very high levels (around 100%). Non-cancerous cell line, showed low sensitivity to all applied modes of magnetic field in short treatment, but their viability dropped down slowly, with time increment. Finally, actin and DAPI staining were performed to observe the structural alterations in cytoskeleton and cell's nuclei after magnetomechanical stress. Indeed, in the cancerous cells after 48-hours pronounced nuclei' and cytoskeleton changes as nuclear expansion/apoptosis and the loss of cortical actin organization and stress fiber formation in pulsed field-mode were observed. After a period of 5 days final stage of nuclear and cytoskeleton destruction was also noticed. On the contrary, for the short treatment of MCF-10A control cells, there were almost no changes in nuclei and cytoskeleton organization. Thus, the results pointed out that the pulsed magnetic field/MNPs applied to cancerous cells not only leads to viability decrease but also to nuclear and cytoskeleton instability.

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In vitro and in vivo study of magnetic nanoparticles with potential for anti-tumor therapy

P04

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In recent years, magnetic nanoparticles (MNPs) have demonstrated progress in the field of anti-tumor therapies including magnetic hyperthermia and magnetomechanical treatment [1, 2]. Cellular uptake of MNPs may cause changes in cytoskeleton network [3], which in turn would lead to various functional alterations, including the inductions of apoptosis and oxidative stress. Since effects as apoptosis is desirable effect which aims to have nanoparticles on cancer cells, then induction of oxidative stress and liver toxicity are among the negative side effects of using MNPs on healthy cells and tissues. For that reason, in this study, we discuss the effects of MNPs on the actin cytoskeleton network and nucleus morphology in MDA-MB-231 and MCF-10A cell lines as well as the induction of oxidative stress and hepatic toxicity by intracerebroventricular (icv) injection of MNPs in ICR mice. The purpose of the study was to distinguish the cellular effect caused by MNPs on cancerous and healthy cells from one side and the examination of *in vivo* effect of MNPs in control mice from another side.

After exposure to 100 μg/ml concentration of MNPs (fluidMAG D, Chemicell GmbH), the MNPs effects on cytoskeleton network and nucleus morphology were observed with fluorescent microscope (Jena Lumar with camera Zeiss and objective HI100x/1,30). Oxidative stress after injection of MNPs in doses of 10-200 μg/kg in mice was evaluated by ELISA assay for superoxide dismutase (SOD) and malondialdehyde (MDA) production. Hepatic toxicity of combined treatment of mice of magnetic field and MNPs was examined by blood test for different serum markers.

Phalloidin-TRITC staining allowed us to document alterations in the cytoskeleton of cancerous and non-cancerous cell lines after treatment with 100 μg/ml MNPs for 24, 48 hours and 5 days. The incubation of the untransformed cells with the MNPs leads to low cell adhesion compared to control cells (cells without MNPs treatment) that are better spread.

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Cortical F-actin was formed, with short filopodia 5.3 μm (24h) and 11 μm (48h) compared to control cells 9.4 μm (24h) and 11.3 μm (48h). At 48 hours, stress fibers are clearly observed in cells incubated with MNPs. 5 days incubation with MNPs induced spike-like filopodium formation. Actin cytoskeleton reorganization was also observed in other treated cancer cell line. Clearly shows uniformly distributed and well aligned action filaments spanning across the control MDA-MB-231 cells (all incubation times). After incubation with 100 μg/ml MNPs from 24 h to 5 days, distinct filamentous actin (cortical actin and stress fibers) can still be seen, albeit less extensive when compared to control. Nuclear morphology remains unchanged, but dark shadows are observed around and on the nuclei, which increase with incubation time (most probably from MNPs accumulation).

In vivo study revealed that MNPs in concentrations between 10 to 200 μg per kg do not cause high oxidative stress in the hippocampus of intact mice. MDA and SOD levels were close to those in the control group, between 40-50 μM and 200-300 U/ml, respectively. Our data show that ICR mice with MNPs had increased serum alanine aminotransferase (ALAT), aspartate aminotranseferase (ASAT), lactate dehydrogenase, urea and creatinine levels, within the reference values 3 hours after icv injection in hippocampus and immediately treated with pulsed magnetic field. After 24 and 48h there were no induction of liver or kidney toxicity, as confirmed by the serum ALAT and ASAT activities and creatinine values, which could be due to rapid elimination of MNPs from the blood circulation. Serum values are like in control group of animals – ALAT (17-77 U/L), ASAT (54-298 U/L), urea (8-33 mg/dL) and creatinine (0.2-0.9 mg/dL).

These results combined with our previous *in vitro* MTT and wound healing studies demonstrate that fluidMAG D nanoparticles are safe for biological systems. MNPs with 100 nm diameter appear to be non-toxic for MCF-10A and MDA-MB-231 cells but exert effects on the cytoskeleton, related to the cell migration. Our *in vivo* results suggest low oxidative stress and lack of hepatic toxicity in ICR mice with application of MNPs/magnetic field. *In vivo* studies showed that the MNPs in the range of 100-200 μg/kg are well biocompatible and could be used in various experiments as hyperthermia or magnetomechanical stress in cancer therapy.

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Synthesis and Characterization of MagnetoElectric $BiFeO_3$ Nanoparticles

P05

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In recent years, considerable attention has been drawn to multiferroic materials because of their fascinating applications in novel electronic devices. They exhibit strong coupling of electric, magnetic and structural order parameters, resulting in the coexistence of ferroelectricity, ferromagnetism and/or ferroelasticity in the same phase. Multiferroic magnetoelectrics maintain a magnetization and dielectric polarization, which can be activated and modulated by an electric field and magnetic field, respectively.

Among the multiferroic materials, $BiFeO_3$ (BFO) receives noticeable attention due to its potential applications (spintronics, data storage microelectronics, etc.) as well as due to the fascinating physics behind its properties. BFO has a rhombohedrally disorted pervoskite structure with space group R3c. In bulk form, it is an antiferromagnetic, ferroelectric and ferroelastic multiferroic material with electrical, magnetic, and structural ordering temperatures well above room temperature. The ferroelectricity of BFO originates from the structural distortion, induced by $6s^2$ lone pair of Bi^{3+} ions, while the G-type antiferromagnetism is owing to the spiral spin structure, formed by Fe^{3+} ions. The combined action of exchange and spin-orbit interactions produces spin canting away from perfect antiferromagnetic ordering. The direction of the resulting small moment rotates, superimposing the aforementioned spiral spin arrangement, with a modulation period of ~62nm. Such a spin structure would cancel its net magnetism in bulk and inhibit the observation of linear magnetoelectric (ME) effect. In addition, the existence of Fe^{2+} and the volatilization of Bi element would always create oxygen vacancies in BFO, and thereby result in a large leakage current, limiting its practical applications. Moreover, during the synthesis process, the emergence of impurity phases such as $Bi_2Fe_4O_9$ and $Bi_{25}FeO_{39}$ is difficult to be avoided, due to the volatilization of some reactants and decomposition of BFO at high temperatures.

In this study, a simple chemical co-precipitation method is proposed for the synthesis of pure single-phase BFO nanopowders with different Fe/Bi molar ratios and at multiple calcination temperatures. Structural characteristics, phase constitutions, magnetic measurements and impedance analysis of BFO were investigated by XRD, FT-IR, SEM-EDX, TG-DTA, Mössbauer spectroscopy, VSM and Magnetic Hyperthermia techniques The main target is to produce BFO nanoparticles with enhanced magnetization due to the suppression of the known spiral spin structure (62nm) and enhanced dielectric properties with smaller leakage currents due to the suppression of impurities and oxygen vacancies, compared with bulk BFO.

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Synthesis and Characterization of Magnetic Bioceramic Nanoparticles for Medical Applications

P06

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Bioceramics have various applications in bone regeneration regeneration and drug delivery. They can stimulate biological and molecular mechanisms in the body and regenerate damaged bone tissue. Most bioceramic systems are based on calcium phosphates such as Bioglass 45S5 and 1393 bioactive glass, hydroxyapatite (HA) and β-Tricalcium Phosphate (β-TCP), or calcium silicates such as akermanite $Ca_2Mg(Si_2O_7)$ and $CaSiO_3$. Silicon (Si) is an essential trace element that participates in a numerous metabolic activities and it plays an important role in processes related to bone growth. Calcium (Ca) promotes the proliferation of osteoblasts, their differentiation and the calcification of extracellular matrix (ECM). Finally, magnesium (Mg) is a very important trace element of bone and plays a critical role in cell differentiation and acceleration of bone remodeling (osteoinduction, osteo-guidance). Due to the abundance of physicochemical and biological properties of magnetic bioceramics, they make them attractive in applications of bone tissue regeneration, either as nanocomposite fillers or implantable materials in bone cavities, thus opening a wide field in tissue engineering. The purpose of this study is the synthesis and characterization of biocompatible magnetic bioceramic nanoparticles, with the aim of their application in regenerative techniques. The aim of this study was to synthesize a number of magnetic bioceramic materials by the two-step high energy ball milling one-pot approach. The bioceramic materials were synthesized by the Stöber method and heat treated at three different temperatures (C1 835°C, C2 1000°C, C3 1100°C) , whereas the magnetite was synthesized by the co-precipitation method. Both synthesized materials were mixed with a planetary HEBM ball milling for different times (1h and 5h) and two wt% ratios (10% and 20%) of magnetite. SEM images revealed that the magnetic bioceramic materials consisted of micro and nano scale particles as well as the homogenously incorporation of all ions (Si, Ca, Mg) and magnetite. FTIR spectra and XRD analysis showed that the composed materials exhibit the characteristic bands of silicate glasses and magnetite. Magnetization values modified accordingly with wt% magnetite concentration as well as with the milling time.

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Oxidative stress analysis, haemolytic activity and cytotoxicity of bioactive glass-ceramics nanomaterials

P07

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Bioactive glass-ceramics are unique synthetic materials that react with biological fluids, inducing osteogenesis and contributing decisively to the success of biointegration. Due to these properties, they are usually used in numerous medical applications, so beyond other properties they have to be hemocompatible. Due to the increased use of nanoparticles in various biomedical fields, their possible toxicity and hemolytic activity constitute emerging and growing issues. The toxicity and haemolytic activity of silica nanoparticles depend on their size, geometry, porosity, and surface charge, due to the presence of silanol groups (OH^-).The aim of this study was the investigation of the in-vitro hemolytic and cytotoxicity behavior of bioactive silicate nanoparticles for bone tissue engineering after incubation with human erythrocytes and the evaluation of reactive oxygen species (ROS) production, in the ternary system SiO_2 55 –CaO 35 –MgO 10 mol%.

The glass was synthesized by the Stöber method and heat treated at three different temperatures after TGA analysis (C1 835°C, C2 1000°C, C3 1100°C). An almost amorphous structure was recorded for C1, while C2 and C3 presented lower amount of amorphous phase and different crystalline phases such as wollastonite, bredigite and merwinite. The haemolytic activity of C1 was the highest, while C2 presented the lowest. Their hemolytic activity was correlated to differences on their percentage of amorphous and crystalline structure, as well as the type of crystalline phases. Cytotoxicity assay did not reveal significant differences among the materials, which all presented acceptable biocompatibility (up to 90% compared to control), with no dose response effects. The oxidative stress analysis showed that much lower levels of MDA and simultaneously much higher levels of GSH at all concentrations are produced for the material C2 compared to the other two materials. Similar results were observed for total free radicals. The levels of free radicals at 41 °C were higher in all three biomaterials at all concentrations compared to the corresponding levels of free radicals at 37 °C. from all the above methods, C2 appears to exhibit enhanced properties compared to C1 and C3. The different behavior of C2 can be justified by differences in crystalline structure after heat treatment.

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Fe-Fe_3O_4 "Core-Shell" Nanoparticles: Synthesis and Characterization

P08

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Iron-magnetite (Fe-Fe_3O_4) nanoparticles with "core-shell" architecture have been synthesized using solid-phase pyrolysis of iron phthalocyanine. This product of pyrolysis additionally annealed at 250°C under the oxygen media produces (Fe_3O_4)/C nanocomposite material. Changing the pyrolysis conditions, it is possible to vary sizes of nanoparticles from 5 to 100 nm. The quantitative composition of the "core-shell" was controlled by changing the concentration of oxygen. Complex structural investigations of these materials are obtained using HRTEM, STEM, X-ray diffraction (XRD) and Raman spectrometers. The HRTEM and HAADF-STEM images with corresponding elemental data mapping are shown in Fig.1.

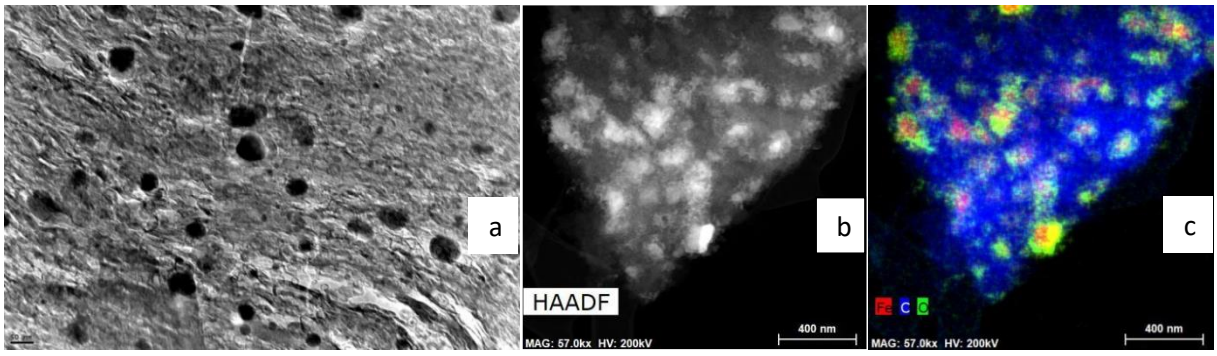

Figure 1. HRTEM micrographs (a) and the HAADF-STEM image with elemental mapping data (b,c) of (Fe-Fe_3O_4) "core-shell" nanoparticles.

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Fe-Fe_3C "Core-Shell" Nanoparticles: Synthesis and Characterization

P09

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Iron-cementite (Fe-Fe_3C) core-shell nanoparticles with an additional carbon shell were synthesized by a solid-phase pyrolysis of iron phthalocyanine. The morphology, sizes and composition of the synthesized nanocomposite were studied by methods of high-resolution transmission and scanning transmission electron microscopes (HRTEM, STEM), Mossbauer spectroscopy, X-ray diffraction and extended absorption fine structure (EXAFS). The mean diameter of Fe-Fe_3C nanoparticles is in the order of 10 nm with cementite concentration of about 60wt%. The desirable "core-shell" architecture of synthesized Fe-Fe_3C nanoparticles is confirmed by the methods of X-ray absorption near-edge structure (XANES) and EXAFS combined with Reactive Force-Field Molecular Dynamic (MD) simulations and magnetometry.

The M-H dependences at the temperatures of 10 K and 300 K show a magnetization jump at low fields. This behavior can be associated with core-shell architecture of Fe-Fe_3C nanoparticles with Fe and Fe_3C coexisting within a single particle. The EXAFS spectra and hysteresis loop are shown in Fig.1.

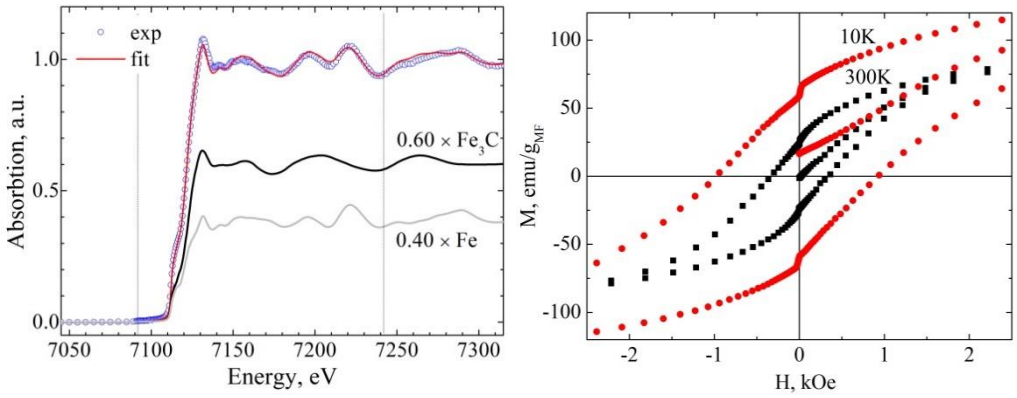

Fig.1. EXAFS spectra and hysteresis loop of Fe-Fe_3C nanoparticles in carbon matrix.

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Novel tissue engineering scaffolds and liposomal formulations loaded with Alkannins/Shikonins for dermal applications

P10

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Alkannins and Shikonins (A/S) are natural products biosynthesized in the roots of several Boraginaceous plants. These molecules have exhibited important pharmacological activities, such as strong wound healing, regenerative, anti-inflammatory and antitumor ones. A/S comprise the active ingredients of several pharmaceutical preparations approved for wound healing and skin regeneration (HELIXDERM®, Histoplastin Red®). An efficient way to improve the therapeutic index of poorly water-soluble bioactive compounds is drug delivery systems (DDS), covering a variety of technologies from nanoparticles to transdermal patches.

In this study, we present two DDS loaded with the APIs A/S: liposomal formulations and electrospun scaffolds, all for dermal applications. Liposomes were prepared by the reverse phase evaporation technique, using PHOSAL® 40IP (containing soybean phosphatidylcholine in sunflower oil, kindly donated by Lipoid GmbH, Ludwigshafen, Germany) and cholesterol. In order to optimize the formulation, various ratios of PHOSAL:Cholesterol and PHOSAL:Drug were examined, monitoring the particle size distribution, ζ-potential values, entrapment efficiency and drug release. The prepared liposomes exhibited mean particle size from 120-200 nm with PDI values ranging between 0.12-0.27, ζ-potential ones ranging from -11 to -18 mV, while entrapment efficiency reached 70%.

For the fabrication of scaffolds, electrospinning technique was applied and several biodegradable polymers were used [cellulose acetate (CA), poly(l-lactide) (PLLA), polycaprolactone (PCL) and polycaprolactone/polyethylene glycol (PCL/PEG)]. A/S-loaded and non-loaded fiber mats were produced. The scaffolds were seeded with human foreskin fibroblast cells (Hs27) and cultured for up to 7 days. Several physicochemical and biological characteristics were evaluated: drug content, in vitro drug release profile, scaffolds morphology and cell attachment by SEM and cell viability at different time points by MTT. All A/S-loaded patches displayed a favorable matrix to cell attachment. After 7 days of culturing, the fiber mats demonstrated adequate cell viability with PCL-A/S and PEGylated PCL-A/S showing increased proliferation compared to non-loaded PCL and PCL/PEG scaffolds. These findings are considered promising and could be used potentially for dermal applications aiming at repairing and regenerating damaged skin tissue.

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An NMR and LC-MS based metabolomics approach to elucidate the mechanism of action of alkannin and shikonin on breast cancer cell line MCF-7

P11

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Cancer is the second leading cause of death globally, a disease that alters the metabolism of a cell and the surrounding environment. New methodologies and tools are urgently needed for cancer diagnosis, prevention and treatment. Metabolomics is a growing technology capable of detecting hundreds of small-molecule metabolites in tissues and biological fluids and thus can elucidate the effect and response of cells under treatment. The recent advances in metabolomics technologies have enabled a deeper investigation into the metabolism of cancer.

Alkannin, shikonin (A/S) and their esters are naturally occurring hydroxynaphthoquinones, biosynthesized mainly in the roots of plants belonging to the Boraginaceae family. Among their well-established biological properties, such as antimicrobial, antioxidative and wound healing activity, A/S and their esters have been extensively studied *in vitro* and *in vivo* for their antitumor activity. However, the exact mechanism of action has not yet been identified.

In this study, we investigated the inhibitory effect of the natural products alkannin and shikonin on human breast cancer cell line MCF-7, and applied an NMR and UHPLC-HRMS untargeted metabolomics approach to gain further insight.

Cytotoxic activity of alkannin and shikonin on MCF-7 cells was examined at different concentrations (0.05 – 5μM). After the implementation of cell viability assay, aliquots of specific groups were taken from both the extracellular and intracellular fluids.

Reversed-Phase UHPLC-HRMS analysis was performed for both intracellular and extracellular extracted material. For this purpose, an ACQUITY UPLC HSS C18 SB 1.8μm (Waters) RP column was used. The linear gradient's elution solvents were A: [H_2O, 0.1% HCOOH], and B: [MeOH, 0.1% HCOOH]; 100% A at t=0; 100% B at t=13min, which remained constant for 2 min.

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The detection was performed by an LTQ Orbitrap XL mass spectrometer. Electrospray ionization was applied in both positive and negative mode.

^{1}H-NMR and 2D-NMR spectroscopy was also applied to the extracted material. Intracellular and extracellular precipitants were resuspended in deuterated methanol and water respectively. TSP was added as internal standard and pH of D_2O was adjusted. NMR spectra were acquired on a 600 MHz Varian spectrometer, and for each 1D NMR spectrum, a total of 256 scans were accumulated into 65.5 K data points with a spectral width of 16 ppm.

Interpretation of metabolic profiling data in both techniques was carried out by multivariate data analysis using SIMCA 13. PLS-DA and OPLS-DA models in the intracellular samples revealed clear separation when shikonin *vs* control group and alkannin *vs* control group discrimination analysis was applied. Components with major contribution to these models were determined and their respective chemical shifts and m/z were defined.

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Nanostructured permanent magnets: Materials, geopolitical prospects, future challenges & recycling

P12

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Permanent magnets (PM) are critical elements that are vastly used in many technological applications, especially in the context of modern policies not only to protect the environment but also to improve energy efficiency and develop the digital economy. High efficiency modern PMs rely heavily on rare earth elements (REE), raw materials of geopolitical and strategic nature which are used in a wide range of consumer products and state-of-the-art applications. In this work, a study of the current state of availability of rare earth elements is presented. Strategies to reduce dependence on PMs are also analyzed. Our analysis focuses on hybrid (HV), all-electric vehicles (EV), NiMH batteries, electric bikes, wind turbines, robotics (domestic/industrial) and consumer electronics (smartphones/HDD), as these technologies have the greatest impact on today's and tomorrow's magnet demand. For the period 2018-2030 a total increase of 171% in Nd and 146% in Dy supplies is expected, quantities that do not seem to be economically feasible to be available. The REE exploitation (or production?) will decrease to 10%, a very low percentage compared to previous decades. It seems that the rate growth of the aforementioned technologies seems to be non-sustainable in the long run. More specifically, after 2021 the demand for Dy and after 2026 the demand for Nd will be greater than their exploitation, which means that not only new RE-free materials should be produced but also the prospect of recycling, should be taken into account. Research is focused on the discovery of new PMs with less RE content. A partial substitution of Sm with an alloy called MischMetal (Ce/La) along with another partial substitution of Co with Fe and Ni took place along with magnetic measurements.

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Superparamagnetic Splenic Macrophages: Magnetic Characterization and Investigation of Immune Response by Low-frequency Magnetic Stimulation

P13

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Nanomedicine has experienced a rapid development in the last decades by use of magnetic nanoparticles for theranostics. Despite various developed applications, the effectiveness of colloidal nanoparticles is limited by biocompatibility and toxicity factors. Therefore, red pulp macrophages (RPM) which have been proven to be superparamagnetic are considered as an alternative route towards remote manipulation. This is possible by iron accumulation by non-functional erythrocyte phagocytosis. Apart from magnetic characterization of RPM, their behavior upon low frequency alternating magnetic fields (LF-AMF) has been investigated in terms of cell viability and proinflammatory cytokine secretion (TNF-α, IL6, CCL5, CCL4).

Murine spleen cells were extracted from BALB/C mice and RPM were separated from unwanted cell groups through magnetic active cell sorting (MACS). The stimulation was carried out by an electromagnet. A realistic computational model of the magnetic field was implemented and the region with the biggest magnetic gradient was determined (B=20 mT, $\nabla \vec{B}$ = 2 T/m). RPM were stimulated at 50 Hz, 250 Hz and 500 Hz for 15 min while a control group was not exposed to the LF-AMF. The cytokine concentration in the supernatant of stimulated RPM was measured by fluorescence spectroscopy (xMap-technology, Luminex™). In order to exclude cell functionality disturbances through the magnetic field, the stimulation was repeated at 50 Hz and 250 Hz followed by addition of lipopolysaccharides (LPS). Furthermore, the iron-containing fraction of RPM has been further isolated and magnetically characterized by magnetometry.

As expected, RPM showed a superparamagnetic behavior above the blocking temperature (T_B ~10 K). The analysis of magnetometry data resulted an average particle magnetic moment of 373±170 μ_B and the average magnetic moment of a single red pulp macrophage was calculated accordingly to $1.671 \cdot 10^{-12}$ Am^2. Cell viability and cytokine concentration resulted from magneto-mechanical stimulation does not indicate any influence of the external LF-AMF. The applied gradient force of 3.3 pN during stimulation turned out to be smaller than the necessary force for evoking changes in the cells' physiological processes while the calculated force during magnetic cell separation has been proven sufficient to filter RPM from the other unwanted cell groups.

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Revolutionary green perovskite or perovskite-like solar cells

P14

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Perovskite Solar Cells (PSCs) attract the focus of the semiconductor optoelectronics community for just over a decade. Their merits over their former generation relatives are the fairly low manufacturing costs, the abundance of their constituents, their molecular tuneability, the easiness of fabrication through liquid chemistry deposition methods, and excellent power conversion efficiencies-equivalent to the best "older age" technologies (*a-Si, CdTe, GaAs, CdSe* etc), exceeding *25%* for single heterojunction devices. A compound is denoted as a Perovskite, if it obeys the general chemical formula of ABX_3. The A site can be a variety of positively charged entities (such as Cs^+, Rb^+, MA^+*-Methylammonium,* FA^+*-Formamidinium* etc). The B site is generally occupied by a heavy positively charged atom, with the most popular one being Lead (Pb^{2+}) for photovoltaic (PV) applications. The X site is dominated by negatively charged atoms mostly, with halogens, or ratios between several of them, being the most used solution [i.e. iodide (I^-), bromide (Br^-), chloride (Cl^-*, although not confirmed to be staying in the crystal lattice*)]. The halogenic presence along the *lead* atom, when combined with one of the aforementioned A site occupants, results in a material with excellent optoelectronic properties. That means that the produced film compound possesses a bandgap suitable to absorb the visible as well as a small portion of the NIR radiation (1,6eV in the case of $MAPbI_3$). To explore that photoactive ability of the created films, sandwich architecture is, then, applied in order to harvest the produced energy. The absorbed energy is bound in an exciton (*electron-hole* pair), which separated almost spontaneously into free carriers which travel throughout the material, only to give that energy in an electrode pair sandwich of surfaces above and below the material, each acting as a pole. Those conductive materials, in sequence, transfer the given energy in the form of electricity, which is harvested through metallic contacts, thermally evaporated on top of the structure. The sole presence of the *Lead* atom though, limits the potential of that unique blending of metals and organic molecules (*HOIP-Hybrid Organic Inorganic Perovskite*), because of its toxicity versus humans. By exploiting the tuneable nature of the perovskitic compounds, we aim to tune the X site, by including another group of negatively charged atoms, in order to create a new lattice which can support a different central B site atom. If we succeed in such a tailoring, the produced compounds will have a huge application potential, with few examples being the photovoltaic devices themselves, photodetectors in almost all spectrum ranges-varying from motion sensors to cosmic ray radiation analysers, display surfaces, without worrying about human proximity due to their greener nature. Last but not least, the greener nature of those materials will make the disposal of devices not environmentally hazardous.

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Blood cancer: New insights of Oxidative stress in carcinogenesis

P15

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An emerging trend in the increase of Blood cancer was observed lately in European countries. Oxidative stress is closely related to all aspects of cancer, from carcinogenesis to the tumor-bearing state, from treatment to prevention. The aim of this study is to evaluate antioxidants such as serum vitamin E and total antioxidant capacity (TAC) but also indicators of oxidative stress such as Malondialdehyde (MDA) and reactive oxygen species (ROS) levels in 80 blood cancer patients with different hematological malignancies (HMs) [acute myeloid leukemia (AML)(n=20), myelodysplastic syndromes (MDS) (n=20), Hodgkin lymphoma (HL) (n=20) and non-Hodgkin lymphoma (NHL) (n=20)] on the day of their diagnosis. Samples from all participants were obtained after an overnight fast (at least 10 hours). This study was approved and conducted in accordance with Good Clinical Practice guidelines and the Declaration of Helsinki. Patients and controls provided written, informed consent before entering the study. All study participants' medical history and their medication were documented upon enrolling. Lower levels of TAC and Vitamin E were observed in most of the studied groups compared to healthy controls (0.41-0.49 mmol/L vs. 0.56 mmol/L) (19.55-28.55 μmol/L vs. 34.51 μmol/L). Moreover, higher average MDA levels were observed in HL and NHL patients compared to healthy controls (16.6 ng/ml-17.8 ng/ml vs. 7.4 ng/ml). Additionally, the ROS values of all studied groups were found elevated. Serum TAC showed significant negative correlations with MDA values ($R= -0.51$; $P<0.001$). Statistical significance was observed in all hematological parameters, producing either positive or negative correlation with at least one OS biomarker. The present data suggest that blood cancer patients with HL and NHL on the day of their diagnosis presented the highest OS in comparison to AML and healthy subjects. Moreover, MDS patients presented high OS status. Likewise, our results also indicated that changes in their hematological indices are eminent of their oxidative and antioxidative status.

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Design and construction of 3D-printed magnetic tools for biomedical applications

P16

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Lab equipment and all manner of scientific tools have been hampered by high costs and the fact that many things are low volume and may even be unique. Meanwhile, applications of 3D printing technologies have become as diverse as the types of materials that can be used for printing. 3D printing has also allowed the scientific and engineering community to build the "little things" that help a lab get up and running much faster and easier than ever before. In the world of magnetism, the development of 3D-printable permanent polymer-based magnets [1] stands very promising since manufacturing processes used to develop permanent magnets are time-consuming as well as demanding very specific and complex machinery to perform complicated processes such as the application of exceptionally high pressures, temperatures, and magnetic fields. In this work, the manufacturing of 3D printed lab tools is proposed by using not only pure plastic (PLA and ABS) but also bonded polymer filaments that present useful properties (conductive, thermosensitive, ferromagnetic filament). Meanwhile, the applicability of the aforementioned tools has been examined in magnetic particle application, as it is shown in Figure, revealing modern ideas on improved experimental protocols. As a result, the development of a magnetically charged plastic filament, a process that has been widely talked about around the world, stands as a feasible and promising next goal.

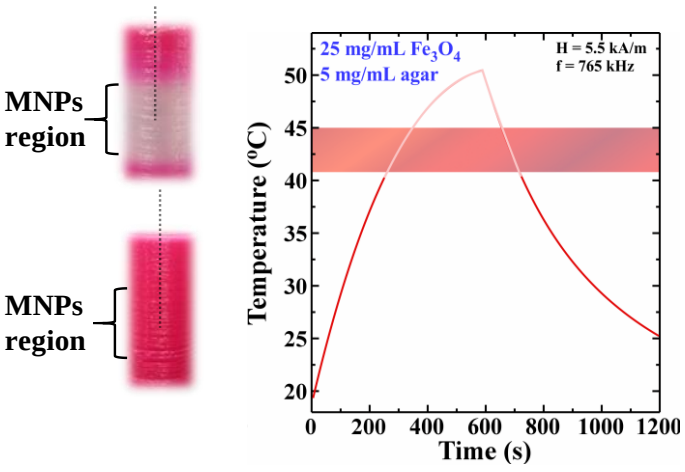

Figure 1. 3D printed tube (left) using color changing polymer filament with temperature (red color changes to natural at 41°C). Hyperthermia temperature curve (right) of magnetite nanoparticles injected into the thermosensitive tube under the application of AC field.

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CoCrFeMnNi High Entropy Alloy Nanoparticles from the Gas Phase

P17

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In 2004 a breakthrough strategy in "material design" was simultaneously introduced by two groups [1]. Whereas conventional alloys are based on one or two principal elements and minor fractions of other elements are added for properties optimization, novel alloys so-called *High Entropy Alloys (HEAs)* are composed of five or more principal elements in equal- or near-equal atomic concentrations. One of the outstanding merits of HEAs is their high phase stability which is contributed by high configurational entropy from multiple components HEAs resulting in high thermal stability and excellent mechanical and physical properties.

However, research has been focused primarily on bulk HEA, ignoring HEA nanoparticles due to the absence of a reliable synthesis. High temperature (>900 °C) is usually required to generate high-entropy structures, whereas by conventional synthetic techniques, such as wet chemistry, the nanoparticles formation takes place at the temperatures below 300 °C. At these temperatures the enthalpy dominates the thermodynamics of solidification leading to formation intermetallic compounds against multicomponent solid solution.

In this work, we report on successful synthesis of CoCrFeMnNi High Entropy Alloy Nanoparticles by means of the inert gas phase condensation of sputtered atomic vapor. The influence of parameter of the particles synthesis such as the composition of the processing gas and the condensation temperature on the NP morphology and crystallinity will be discussed.

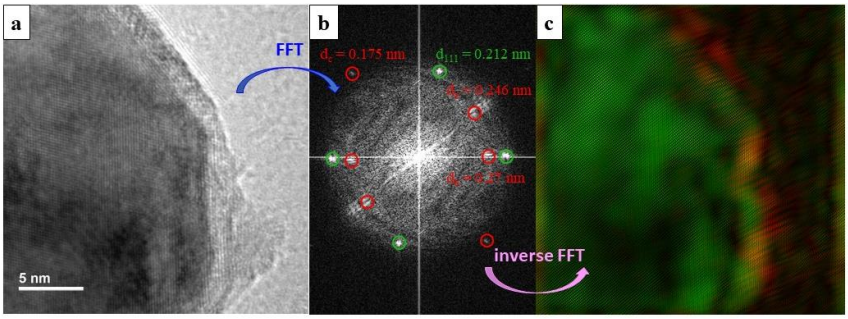

Fig. 1. a) HRTEM image of CoCrFeMnNi nanoparticle, b) Fast Fourer Transfom (FFT) from image a); c) Image created by inverse FFT of selected reflexes.

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Standardizing magnetic hyperthermia experiment: a protocol for a reliable measurement

P18

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Measurement of specific loss power (SLP) of magnetic nanoparticles is crucial to assert the heating potential in magnetic hyperthermia. There has been a significant improvement in characterizing magnetic nanoparticles' heat-triggered functions by many research groups. However, optimal experimental conditions along with notable determination methods of the SLP in magnetic hyperthermia have not been widely proposed until now. Despite the remarkable progress in this field, the evaluation process of SLP suffers from uncertainties and errors imposed not only by experimental parameters (depending on the particles, the conditions and the measurement) but by the estimation methodology, as well. In this work, we propose a step by step standardization protocol, starting from definition and recording of potential uncertainty and error sources, present during a typical magnetic hyperthermia experimental protocol. The error of each specific parameter is estimated and translated to ultimate heating efficiency evaluation. According to our analysis, magnetic hyperthermia experiment and its corresponding estimation, under non-adiabatic conditions, may lead to a propagated uncertainty up to 14% on the SLP value. Meanwhile, different heating evaluation methods were assessed under a wide range of experimental conditions, with the 'modified law of cooling' proving to be the most accurate one—limiting the SLP uncertainty to values under 5%—compared to the 'initial slope' and 'Box–Lucas' methods, which show a remarkable uncertainty of over 15%. All parameters involved in the heating efficiency evaluation and their associated uncertainties analysis presented in this work, are included in a standardisation protocol, a handy guideline for determining accurate, reliable and reproducible SLP values, thus adequately evaluating its impact in potential bioapplications.

This research is co-financed by Greece and the European Union (European Social Fund- ESF) through the Operational Programme «Human Resources Development, Education and Lifelong Learning» in the context of the project "Reinforcement of Postdoctoral Researchers - 2nd Cycle" (MIS-5033021), implemented by the State Scholarships Foundation (IKY).

A Multiphysic Model for the Hyperthermia Treatment of Residual Bone Tumors Cells Using Magnetic Scaffolds

P19

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To avoid high recurrence rate, the hyperthermia treatment (HT) of bone tumors after surgical intervention was investigated. The need for a graft or a prosthesis calls for a functional and smart material. Therefore, magneto-responsive material has been investigated. The manufacturing of scaffold which embed magnetic nanoparticles or intrinsic magnetic bioceramics open a wide range of clinical possibilities. Indeed, such innovative magnetic biomaterials can be used as thermo-seeds to perform local, interstitial thermal therapy. This work addresses the multiphysic modeling of the HT of residual bone tumor cells using the so-called magnetic scaffolds.

The goal is to develop a model that can serve as a tool to plan an accurate, safe, and high-quality treatment. Therefore, the non-linear and coupled electromagneto-thermal problem of radio-frequency heating is solved to determine the spatial and temporal evolution of the temperature field in a simplified 2-D geometry of proximal humerus. The commercial FEM software Comsol Multiphysic (v5.3a, Comsol Inc., Burlington MA, USA) is used. The electromagnetic and thermal properties of the scaffold and biological tissues are assumed to be depend on temperature. Different assumptions about the nonuniformity of the external magnetic field are verified. The possibility of nonideal distribution of magnetic nanoparticles in the biomaterial is accounted for the first time. This allows to account for the manufacturing uncertainty of the magnetic nanocomposite. The pattern of the magnetic field and of the induced electric field is studied in both target and healthy tissues. Moreover, the spatio-temporal evolution of temperature is investigated in the different cases.

From the numerical results it is possible to infer that the rather different approach in modeling the RF source can lead to an overestimation of the field amplitude and may compromise the treatment planning or the biological outcome. Moreover, the different MNPs distribution is found to have a strong influence on the way the heat is conducted to the tumor. With these improvements to the state-of-the-art model of the HT of bone tumors, it was possible to identify the field parameter which allows to deliver the therapeutic thermal dose to OS cells.

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X-ray spectroscopic study of magnetic ferrite nanoparticles for theranostic applications: effect of size and distribution

P20

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Magnetic nanoparticles (MNP) with well-defined structural, physical and chemical characteristics are used in hyperthermia towards tumor destruction. The heat conversion efficiency of the MNPs, besides the magnetic field intensity and frequency, is mainly influenced by their size as well as the structural (nanostructure) and chemical (valence) characteristics of the metals involved. We apply combined SR-based μ-XRF mapping and macro-Fe-*K*-XAFS measurements in an effort to investigate the spatial distribution, bonding environment and oxidation state of Fe in Fe_3O_4 MNPs of various sizes prior to and after hyperthermia. As shown in Fig. 1 for two studied MNPs with sizes 10 and 200 nm, the distribution of Fe appears more inhomogeneous in the NPs having the smaller size (10 nm), prior to hyperthermia; Fe appears to segregate and form clusters approximately 100 μm in size. Hyperthermia though leads to the extensive clustering of the widely dispersed Fe-rich inclusions. The strong tendency for the formation of Fe-rich regions is not prominent in the case of the large (200 nm) MNPs. Only dispersed smaller in size (≈50 μm) Fe-rich segregates are detected which however, dissolve after treatment. Thus, hyperthermia enhances segregation of the magnetite NP; nevertheless, in the case of the larger NP, it results in complete dissolution. The Fe-*K*-XAFS analysis results reveal changes in the oxidation state of Fe, i.e. partial oxidation of Fe^{2+} species to Fe^{3+} as well as modification in site occupancy.

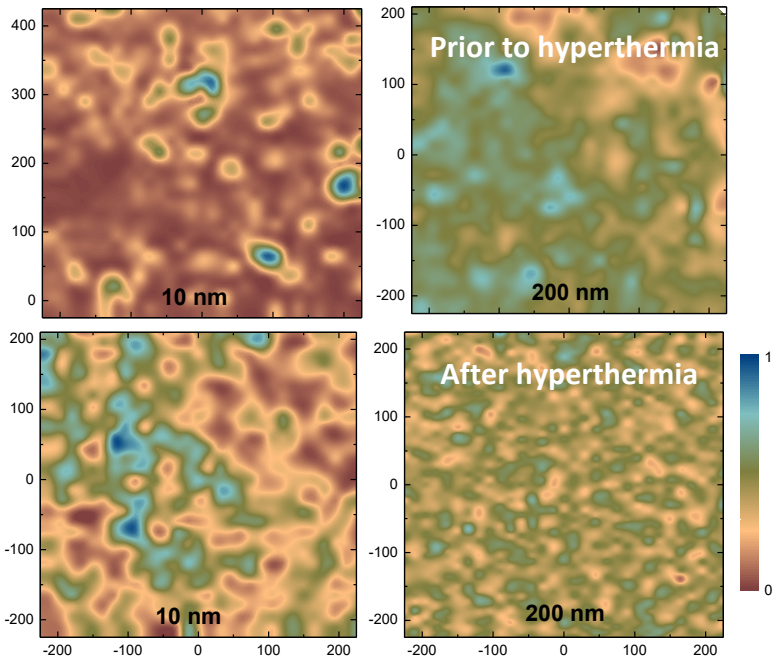

Fig. 1: 2D XRF maps of the studied Fe_3O_4 NPs with a diameter equal to 10 and 200 nm, respectively prior to (upper panel) and after hyperthermia (lower panel).

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Estimating the effective anisotropy of ferromagnetic nanoparticles through magnetic and calorimetric simulations

P21

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Magnetic nanoparticle-mediated hyperthermia holds great promise as a treatment for cancer. The key measure used for characterizing the heating efficiency of nanoparticles in this context is the specific loss power, which may be derived from the magnetic hysteresis loop area. An intrinsic property of magnetic nanoparticles that influences specific loss power is magnetic anisotropy, which is difficult to estimate because of its complicated nature. This work presents a simple method for the theoretical estimation of magnetic anisotropy in ferromagnetic magnetite nanoparticles of 40 nm diameter. We conduct numerical calculations of hysteresis loops, employing a Monte Carlo technique for a typical anisotropy range of 2 to 11 kJ/m^3. By estimating numerically the hysteresis loop area, we found that magnetic nanoparticles heating efficiency reaches 30 - 470 W/g for anisotropy values 2 - 11 kJ/m^3 respectively. Specific loss power values are then compared to the corresponding theoretical values which were found in literature and obtained by analytical models based on the Stoner-Wohlfarth model-based theories. Numerical and analytical specific loss power values were in good agreement. The values of the effective anisotropy are also in the domain of validity of the Stoner-Wohlfarth model-based theories in order to correspond to weakly anisotropic MNPs with magnetic anisotropy values ≤ 11kJ/m^3 which are typically observed in the ferromagnetic regime of magnetite magnetic nanoparticles and are predicted by these theories. An increase of the specific loss power values with the anisotropy increase is observed. To assess the validity of our simulations and to estimate the optimum anisotropy for our magnetic nanoparticles, we compare numerically estimated loops to an experimental one. Using the finite element method, we perform heat transfer simulations to calculate temporal temperature distributions in an aqueous dispersion of magnetic nanoparticles for a fixed range of anisotropy values. Simulated heating curves are compared with experimental ones to verify magnetic nanoparticle anisotropy which coincides with the one obtained from the Monte Carlo simulations above and is equal to 9 kJ/m^3. Therefore, in this study, we propose a rigorous quantification of the anisotropy of ferromagnetic nanoparticles both magnetically and calorimetrically through hysteresis loops estimation and heat transfer simulations, respectively, so that their specific loss power can be accurately determined and used for treatment planning in clinical practice.

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Nanoimprint Defined Magnetic Nanoplatelets for Cancer Treatment and Biomedicine

P22

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Magnetic nanoparticles are widely used in bio-application due to their ability to remotely manipulate their surroundings. Here, we show novel magnetic nanoplatelets based on synthetic antiferromagnetic (SAF) stacks [1]. These stacks are consisting of multiple repeats of [Pt/CoB/Ru/CoB/Pt], where the two magnetic layers are antiferromagnetic coupled through a Ru spacer layer as shown in Figure 1. These particles exhibit zero magnetic moment in zero magnetic field preventing agglomeration in fluids. Moreover, the response to magnetic fields can be fully customized. In addition, these nanoplatelets exhibit a strong perpendicular magnetic anisotropy, which makes them ideal candidates for applications that rely on the application of local mechanical forces or torques, such as cancer therapy based on mechanical cell disruption [2].

In this poster, we will present a new top-down method to fabricate monodisperse SAF nanoplatelets through substrate conformal nanoimprint lithography (SCIL). Compared to other fabrication methods, SCIL can easily be used to produce particles with size down to tens of nanometers at a large scale. We will show that the SAF nanoplatelets maintain their perpendicular anisotropy and antiferromagnetic properties as compared to blanket thin film stack.

Figure 1. Basic unit of the SAF stack

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Magnetic characterization of Fe/Fe_3C nanoparticles fabricated by solid state pyrolysis

P23

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Carbon-encapsulated iron-cementite (Fe-Fe_3C) nanoparticles, promising nanomaterials for medicine due to their valuable magnetic properties [1], were synthesized by a single-step solid-state pyrolysis of iron phthalocyanine at different temperatures from 700°C up to 1000°C [2]. Transmission Electron Microscopy and X-Ray diffraction studies reveal the particles of 10-20 nm composed mostly of cementite with a small content of iron which increases with increasing the pyrolysis temperature. The nanoparticles exhibit a ferromagnetic response at room temperature. The saturation magnetization of the samples increases with increasing the pyrolysis temperature indicating a rise in an iron content in agreement with the structural studies.

The coercivity and the saturation magnetization of the samples increase with decreasing temperature. Effective anisotropy constants, obtained from an analysis of approach of magnetization to saturation, are nearly the same for all samples $\left(\sim 1.5\text{x}10^4 \frac{J}{m^3}\right)$ which is one order lower than that for the bulk cementite $\left(\sim 3\text{x}10^5 \frac{J}{m^3}\right)$ [3].

Annealing of the samples results in a partial decomposition of cementite into iron and carbon at 750°C-800°C.

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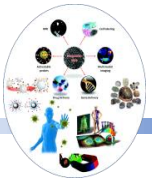
Poster Presentations

Num	Title & Presenting Author
P01	Regional Focus effect on Magnetic Particle Hyperthermia ***E. Myrovali**, MagnaCharta, CIRI-AUTH, Thessaloniki Greece*
P02	Combinatory magnetothermal and magnetomechanical stress on human breast cell lines ***A. R. Tsiapla**, MagnaCharta, CIRI-AUTH, Thessaloniki Greece*
P03	In vitro response of normal and cancerous cell lines under magneto-mechanical activation ***A. R. Tsiapla**, MagnaCharta, CIRI-AUTH, Thessaloniki Greece*
P04	In vitro and in vivo study of magnetic nanoparticles with potential for anti-tumor therapy ***V. Uzunova**, Institute of Biophysics and Biomedical Engineering, BAS, 1113 Sofia, Bulgaria*
P05	Synthesis and Characterization of MagnetoElectric $BiFeO_3$ nanoparticles ***K. Papadopoulos**, MagnaCharta, CIRI-AUTH, Thessaloniki Greece*
P06	Synthesis and characterisation of magnetic bio ceramics nanoparticles for medical applications ***K. Kazeli***, International Hellenic University, Thessaloniki, Greece
P07	Oxidative stress analysis, haemolytic activity and cytotoxicity of bioactive glass-ceramics nanomaterials ***K. Kazeli***, International Hellenic University, Thessaloniki, Greece
P08	Fe-Fe_3O_4 "Core-Shell" Nanoparticles: Synthesis and Characterization ***G. Chilingaryan***, *Institute for Physical Research, National Academy of Sciences of Armenia, Ashtarak, Armenia*
P09	Fe-Fe_3C "Core-Shell" Nanoparticles: Synthesis and Characterization, ***H. Gyulasaryan***, *Institute for Physical Research, National Academy of Sciences of Armenia, Ashtarak, Armenia*
P10	Novel tissue engineering scaffolds and liposomal formulations loaded with Alkannins/Shikonins for dermal applications ***A. S. Arampatzis, A. E. Koletti,** Chemical Engineering Department, Aristotle University, Thessaloniki-Greece*
P11	An NMR and LC-MS based metabolomics approach to elucidate the mechanism of action of alkannin and shikonin on breast cancer cell line MCF-7 ***A. Nakas**, Chemical Engineering Department, Aristotle University, Thessaloniki-Greece*
P12	Nanostructured permanent magnets: Materials, geopolitical prospects, future challenges & recycling ***G. Sempros**, School of Physics, Aristotle University of Thessaloniki-Greece*
P13	Superparamagnetic Splenic Macrophages: Magnetic Characterization and Investigation of Immune Response by Low-frequency Magnetic Stimulation ***N. Tetos**, Fakultät für Physik, Universität Duisburg-Essen-Germany*
P14	Revolutionary green perovskite or perovskite-like solar cells ***L. Theofylaktos**, NCSR Demokritos, Athens-Greece*
P15	Blood cancer: New insights of Oxidative stress in carcinogenesis ***I. Tsamesidis**, Université de Toulouse, IRD, UPS, Toulouse, 31400, France*
P16	Design and construction of 3D-printed magnetic tools for biomedical applications ***P. Kyriazolopoulos**, MagnaCharta, CIRI-AUTH, Thessaloniki-Greece*
P17	CoCrFeMnNi High Entropy Alloy Nanoparticles from the gas phase ***I. N. Sahin**, Fakultät für Physik, Universität Duisburg-Essen-Germany*
P18	Standardizing magnetic hyperthermia experiment: a protocol for a reliable measurement ***A. Makridis,** MagnaCharta, CIRI-AUTH, Thessaloniki Greece*
P19	A Multiphysics Model for the Hyperthermia Treatment of Residual Bone Tumors Cells Using Magnetic Scaffolds, ***M. B. Lodi**,* Dept. Electrical and Electronic Engineering, University of Cagliari, Cagliari Italy
P20	X-ray spectroscopic study of magnetic ferrite nanoparticles for theranostic applications: effect of size and distribution, ***F. Pinakidou**, School of Physics, Aristotle University of Thessaloniki-Greece*
P21	Estimating the effective anisotropy of ferromagnetic nanoparticles through magnetic and calorimetric simulations, ***N. Maniotis,** MagnaCharta, CIRI-AUTH, Thessaloniki Greece*
P22	Nanoimprint Defined Magnetic Nanoplatelets for Cancer Treatment and Biomedicine ***J. Li**, Department of Applied Physics, Eindhoven University of Technology-Netherlands*
P23	Magnetic characterization of Fe/Fe_3C nanoparticles fabricated by solid state pyrolysis ***E. Papadopoulou**, Fakultät für Physik, Universität Duisburg-Essen-Germany*



Training Workshop & Summer School on Magnetic Nanohybrids for Cancer Therapy

Thessaloniki-Greece, August 25-28/2020

Program

	Tuesday 25.08.2020	Wednesday 26.08.2020	Thursday 27.08.2020	Friday 28.08.2020
$09^{00} - 11^{00}$	*Arrivals*	**Materials & Structure** **O04: M. Spasova, Germany** *Characterization of nanomaterials using transition electron microscopy* **O05: C. Dendrinou, Greece** *Nano-Theranostics based on magnetic ferrite nanoparticles* **O06: M. Katsikini, Greece** *Application of X-ray absorption fine structure spectroscopies for the study of $Fe_{3-x}Mn_xO_4$ nanoparticles*	**Biomedical constraints** **O12: G.Litsardakis, Greece** *Magnetic liposomes as versatile clinical carriers* **O13: M. Efremova, Germany** *Magnetite-Gold nanohybrids as ideal platforms for theranostics* **O14: U. Hofmann, Germany** *The Blood-Brain-Barrier as target for magnetic nanoparticle imaging and opening*	**Cancer specific aspects** **O17: C. Chlichlia, Greece** *Enhancing cancer immunotherapy through Nanotechnology* **O18: M. Abakumov, Russia** *Magnetic nanoparticles for cancer therapy and diagnostics: effects of morphology and coating* **O19: C. Tapeinos, Italy** *Cell membrane-coated magnetic nanocubes for the treatment of glioblastoma*
11^{00} - 11^{40} *Coffee Break*				
$11^{40} - 13^{00}$	*Registration On Site & Web*	**Magnetism & Properties** **O07: P. Trohidou, Greece** *Tuning structure and Magnetic Properties of Nanoparticles for Enhanced Heating Performance* **O08: U.Wiedwald, Germany** *Basics of Magnetometry and How to Apply on Nanoparticles*	**Biomedical constraints** **O15: C. Spiridopoulou, Greece** *Cancer nanomedicine: considerations for the in vitro experimental design* **O16: R. Tzoneva, Bulgaria** *How cells respond to magnetic field? Magnetic hyperthermia for cancer treatment*	**Cancer specific aspects** **O20: S. Spirou, Greece** *The Radiobiological Basis of Radiation Therapy and Hyperthermia* **O21: N. Carvou, UK** *Magnetic Particle Imaging Applications in Cancer Inflammation, Theranostics, and Cell Tracking* **O22: T. Samaras, Greece** *Combinatory, Magnetic or Non-magnetic cancer modalities?*
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$17^{00} - 17^{30}$ *Coffee Break*				
17^{30}-19^{30}	**Lab Course 01** **Young researchers Present & Publish** **M. Farle, Germany** *How to make a good scientific oral presentation* ***C. Bratsas, S. Zapounidou, Greece*** *How to avoid predatory journals & plan your publication strategy*	**Lab Course 02** **Young researchers Propose & Manage** **G. Brandon, Luxemburg** *H2020 MSCA Individual Fellowships for the young researchers*	**Lab Course 03** **Young researchers Samples & Biomedicine** **E. Myrovali & K. Kazeli, Greece** *Hands on Samples for biomedical applications*	**Lab Course 04** **Young researchers Magnetic Hyperthermia** **A.R. Tsiapla, N. Maniotis & A. Makridis, Greece** *Hands on Magnetic Particle hyperthermia: Experiment & Evaluation*

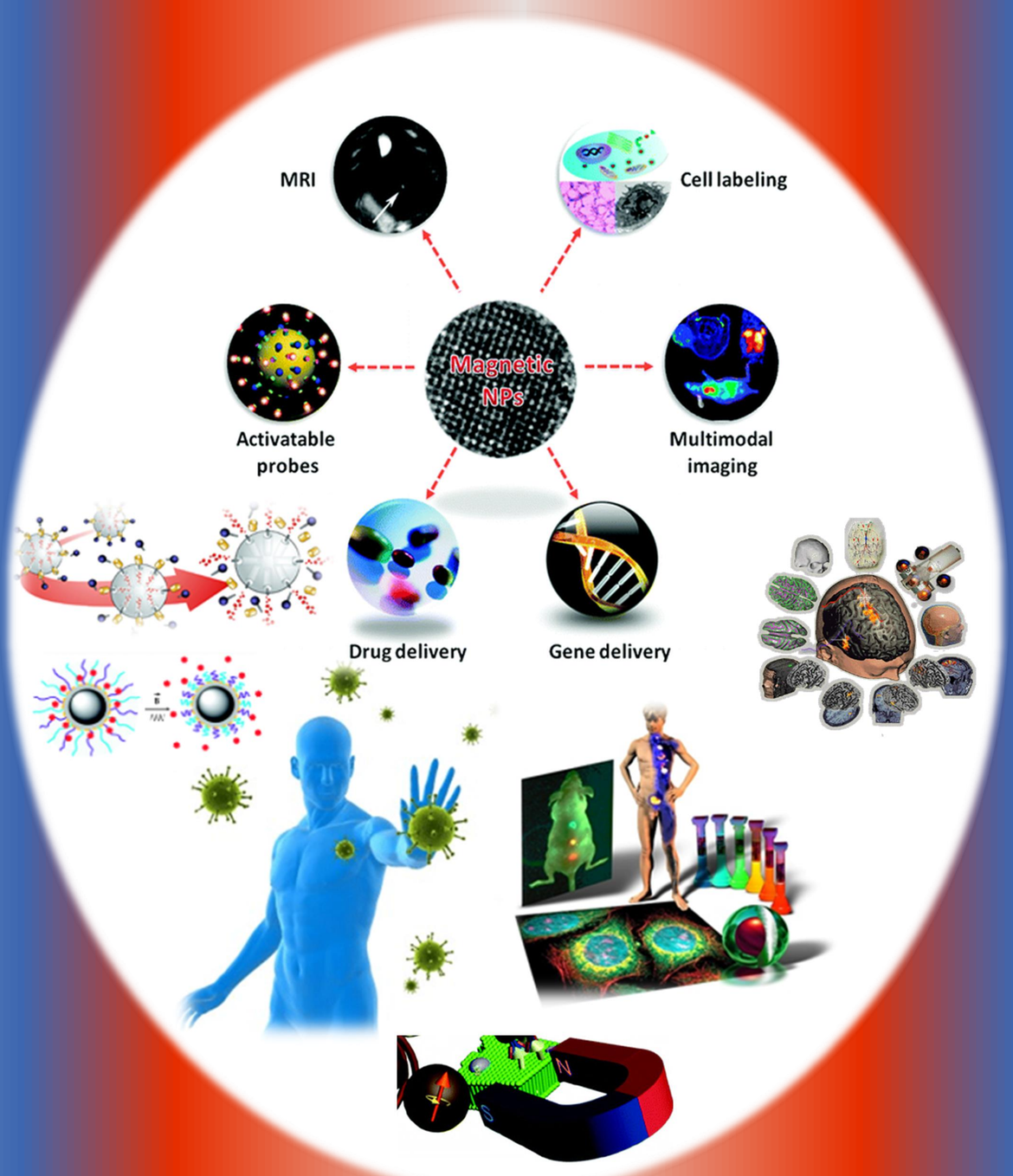
Annex 4

Scientific Programme for the 2nd Training Workshop
(Side note: The SP is mistakenly entitled "1st Training Workshop …")

1st Training Workshop & Summer School

On Magnetic Nanohybrids for Cancer Therapy

within the framework of the MaNaCa Twinning|Horizon2020 project: grant agreement No 857502 (2019-2022)



25-28 August 2020

Balkan Center-CIRI-AUTh, Thessaloniki-Greece

http://magnacharta.physics.auth.gr/manaca-workshop.htm

Magnetic Nanostructure Characterization: Technology & Applications

Contact Person: M. Angelakeris, tel. ++302310998172

email: magnacharta@physics.auth.gr

http://magnacharta.physics.auth.gr

Lab Courses

Tuesday, August 26, 2020
17^{30}-19^{30}

Lab Course 01: Young researchers: Present & Publish

M. Farle, Germany: *How to make a good scientific oral presentation*
***C. Bratsas, S. Zapounidou, Greece**: How to avoid predatory journals and plan your publication strategy*

Oral presentations at a conference or internal seminar are for sharing your research work with other scientists. They must convince the audience that the research presented is important, valid, and relevant to them. To this end, oral presentations must emphasize both the motivation for the work and the outcome of it, and they must present just enough evidence to establish the validity of this outcome. They are localized in space and time, they impose a sequence and rhythm to the audience, and they normally include some level of interaction.

Predatory publishing, sometimes called write-only publishing or deceptive publishing, is an exploitive academic publishing business model that involves charging publication fees to authors without checking articles for quality and legitimacy and without providing the other editorial and publishing services that legitimate academic journals provide, whether open access or not. They are regarded as predatory because scholars are tricked into publishing with them, although some authors may be aware that the journal is poor quality or even fraudulent. According to one study, 60% of articles published in predatory journals receive no citations over the five-year period *following publication.*

Wednesday, August 27, 2020
17^{30}-19^{30}

Lab Course 02: Young researchers: Propose & Manage

G. Brandon, Luxemburg: *H2020 MSCA Individual Fellowships for the young researchers*

What are the MSCA Individual Fellowships? Grants provided by Marie Skłodowska-Curie Actions are available for all stages of a researcher's career, irrespective of nationality. Fellows include PhD candidates and those carrying out more advanced research. Researchers working across all disciplines, from life-saving healthcare to 'blue-sky' science, are eligible for funding. Because they encourage individuals to work in other countries, the MSCA make the whole world a learning environment. They encourage collaboration and sharing of ideas between different industrial sectors and research disciplines – all to the benefit of the wider European economy. MSCA also back initiatives that break down barriers between academia, industry and business. By means of the MSCA Individual Fellowships scientists have the possibility to gain experience abroad and in the private sector, and to complete their training with competences or disciplines useful for their careers.

Thursday, August 26, 2020
17^{30}-19^{30}

Lab Course 03: Young researchers: Samples & Biomedicine

E. Myrovali & K. Kazeli, Greece: Hands on Samples for biomedical applications

Iron oxide nanoparticles (MNPs) have emerged as one of the primary nanomaterials for biomedical applications due to their long blood retention time, their biodegradability and their low toxicity. They can be used in technological applications, including clinical needs such as magnetic hyperthermia. Among the widely used synthesis routes used for synthesizing iron oxide MNPs are coprecipitation, thermal decomposition, microemulsion, and sol-gel methods. However, compared to other synthesis routes, the coprecipitation method is generally preferred due to its high yield and facile controls. More specifically, for the coprecipitation reaction, the concentration of precursors and the reaction temperature significantly affect the size, size distribution, phase and surface chemistry of resultant MNPs. First, we present the synthetic route using the aqueous chemical coprecipitation method. It has been highlighted as a cost-effective and fast process, easily expandable on an industrial level. Using the aqueous version of this method, we may avoid the use of hazardous solvents and reagents and high reaction temperatures or pressures. In that sense, aqueous coprecipitation can be considered to be eco-friendly. It is the simplest method to prepare MNPs from aqueous iron salt (Fe^{2+}, Fe^{+3}) solution. Next, we present the fabrication processes used to produce phantom with agarose solution. Gels and especially those from agarose, are routinely used as phantom models while they comprise the only transparent porous materials which successfully simulate animal tissues.

Friday, August 26, 2020
17^{30}-19^{30}

Lab Course 04: Young researchers: Magnetic Hyperthermia

A.R. Tsiapla, N. Maniotis, A. Makridis, Greece: *Hands on Magnetic Particle Hyperthermia: Experiment & Evaluation*

This Lab Course is focusing on the experiment as well as on the evaluation of Magnetic Particle Hyperthermia. After a brief introduction on the magnetic hyperthermia origin following a short presentation on the Magna Charta lab devices and equipment, the experimental process will be analyzed and presented in a real-time demonstration. Adjusted protocols and experimental strategies will be presented, targeting to the best heating results under harmless routes. Experimental part ends with the heating evaluation of the examined nanoparticle system.

Next, the computational approach of the aforementioned experiments will be presented. More specifically, recommended strategies on how to build numerical models for the description of the phenomena that take place in a Magnetic Hyperthermia *in vitro* system will be shown. In particular, we aim at the estimation of the spatial distribution of the magnetic field and the spatiotemporal temperature distribution by taking into account all the appropriate field and heat transfer boundary conditions. Moreover, we will demonstrate computationally a strategy, to mitigate eddy currents heating, by applying the external magnetic field intermittently (in an ON/OFF fashion), instead of the continuous mode typically used in Magnetic Hyperthermia studies.

Finally, a 3D-printed device for studying an alternative bio-application of applied magnetic fields on MNPs and cells, known as magnetomechanical effect, will be introduced and presented to participants.

Poster Presentations

Num	Title & Presenting Author
P01	Regional Focus effect on Magnetic Particle Hyperthermia ***E. Myrovali**, MagnaCharta, CIRI-AUTH, Thessaloniki Greece*
P02	Combinatory magnetothermal and magnetomechanical stress on human breast cell lines ***A. R. Tsiapla**, MagnaCharta, CIRI-AUTH, Thessaloniki Greece*
P03	In vitro response of normal and cancerous cell lines under magneto-mechanical activation ***A. R. Tsiapla**, MagnaCharta, CIRI-AUTH, Thessaloniki Greece*
P04	In vitro and in vivo study of magnetic nanoparticles with potential for anti-tumor therapy ***V. Uzunova**, Institute of Biophysics and Biomedical Engineering, BAS, 1113 Sofia, Bulgaria*
P05	Synthesis and Characterization of MagnetoElectric $BiFeO_3$ nanoparticles ***K. Papadopoulos**, MagnaCharta, CIRI-AUTH, Thessaloniki Greece*
P06	Synthesis and characterisation of magnetic bio ceramics nanoparticles for medical applications ***K. Kazeli***, International Hellenic University, Thessaloniki, Greece
P07	Oxidative stress analysis, haemolytic activity and cytotoxicity of bioactive glass-ceramics nanomaterials, ***K. Kazeli***, International Hellenic University, Thessaloniki, Greece
P08	Fe-Fe_3O_4 "Core-Shell" Nanoparticles: Synthesis and Characterization ***G. Chilingaryan***, *Institute for Physical Research, National Academy of Sciences of Armenia, Ashtarak, Armenia*
P09	Fe-Fe_3C "Core-Shell" Nanoparticles: Synthesis and Characterization, ***H. Gyulasaryan***, *Institute for Physical Research, National Academy of Sciences of Armenia, Ashtarak, Armenia*
P10	Novel tissue engineering scaffolds and liposomal formulations loaded with Alkannins/Shikonins for dermal applications ***A. S. Arampatzis, A. E. Koletti,** Chemical Engineering Department, Aristotle University, Thessaloniki-Greece*
P11	An NMR and LC-MS based metabolomics approach to elucidate the mechanism of action of alkannin and shikonin on breast cancer cell line MCF-7 ***A. Nakas**, Chemical Engineering Department, Aristotle University, Thessaloniki-Greece*
P12	Nanostructured permanent magnets: Materials, geopolitical prospects, future challenges & recycling, ***G. Sempros**, School of Physics, Aristotle University of Thessaloniki-Greece*
P13	Superparamagnetic Splenic Macrophages: Magnetic Characterization and Investigation of Immune Response by Low-frequency Magnetic Stimulation, ***N. Tetos**, Fakultät für Physik, Universität Duisburg-Essen-Germany*
P14	Revolutionary green perovskite or perovskite-like solar cells ***L. Theofylaktos**, NCSR Demokritos, Athens-Greece*
P15	Blood cancer: New insights of Oxidative stress in carcinogenesis ***I. Tsamesidis**, Université de Toulouse, IRD, UPS, Toulouse, 31400, France*
P16	Design and construction of 3D-printed magnetic tools for biomedical applications ***P. Kyriazolopoulos**, MagnaCharta, CIRI-AUTH, Thessaloniki-Greece*
P17	CoCrFeMnNi High Entropy Alloy Nanoparticles from the gas phase ***I. N. Sahin**, Fakultät für Physik, Universität Duisburg-Essen-Germany*
P18	Standardizing magnetic hyperthermia experiment: a protocol for a reliable measurement ***A. Makridis,** MagnaCharta, CIRI-AUTH, Thessaloniki Greece*
P19	A Multiphysics Model for the Hyperthermia Treatment of Residual Bone Tumors Cells Using Magnetic Scaffolds, ***M. B. Lodi**,* Dept. Electr. & Electron. Engin. University of Cagliari, Cagliari Italy
P20	X-ray spectroscopic study of magnetic ferrite nanoparticles for theranostic applications: effect of size and distribution, ***F. Pinakidou**, School of Physics, Aristotle University of Thessaloniki-Greece*
P21	Estimating the effective anisotropy of ferromagnetic nanoparticles through magnetic and calorimetric simulations, ***N. Maniotis,** MagnaCharta, CIRI-AUTH, Thessaloniki Greece*
P22	Nanoimprint Defined Magnetic Nanoplatelets for Cancer Treatment and Biomedicine ***J. Li**, Department of Applied Physics, Eindhoven University of Technology-Netherlands*
P23	Magnetic characterization of Fe/Fe_3C nanoparticles fabricated by solid state pyrolysis ***E. Papadopoulou**, Fakultät für Physik, Universität Duisburg-Essen-Germany*

Thessaloniki-Greece, August 25-28/2020

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Annex 5

List of participants of the 2nd Training Workshop

Num	Onsite-web	Surname	FirstName	Title	Affiliation01	City-Country
1	web	Tapeinos	Chris	Dr.	Istituto Italiano di Tecnologia	Pontedera-Italy
2	web	Kamzin	Aleksandr	Prof.	Ioffe Institute, Russian Academy of Sciences	Saint Petersburg-Russia
3	web	Serantes	David	Dr.	Instituto de Investigacións Tecnolóxicas and Applied Physics Department, Universidade de Santiago de Compostela	Santiago de Compostela-Spain
4	web	Tzoneva	Rumiana	Dr.	Inst. Biophysics & Biomedical Engineering, Academy of Sciences	Sofia-Bulgaria
5	web	Uzunova	Veselina	Dr.	Inst. Biophysics & Biomedical Engineering, Academy of Sciences	Sofia-Bulgaria
6	Onsite	Simeonidis	Konstantinos	Dr.	School of Physics, Aristotle University	Thessaloniki-Greece
7	Onsite	Lymperaki	Evgenia	Prof.	Dept. of Biomedical Sciences, Int. Hellenic University	Thessaloniki-Greece
8	web	Tsamesidis	Ioannis	Dr.	Université de Toulouse, IRD, UPS, Toulouse, 31400, France	Thessaloniki-Greece
9	Onsite	Maniotis	Nikolaos	Dr.	MagnaCharta, Aristotle University	Thessaloniki-Greece
10	Onsite	Kontonasaki	Eleana	Prof.	Department of Dentistry, Aristotle University	Thessaloniki-Greece
11	Onsite	Tsiapla	Aikaterini-Rafailia	PhD	MagnaCharta, Aristotle University	Thessaloniki-Greece
12	Onsite	Myrovali	Eirini	Dr.	MagnaCharta, Aristotle University	Thessaloniki-Greece
13	Onsite	Papadopoulos	Kyrillos	MSc	MagnaCharta, Aristotle University	Thessaloniki-Greece
14	Onsite	Kyriazopoulos	Pavlos	BSc	MagnaCharta, Aristotle University	Thessaloniki-Greece
15	Onsite	Theofylaktos	Lazaros	PhD	School of Chemistry, Aristotle University	Thessaloniki-Greece
16	Onsite	Koleti	Antigoni	PhD	School of Chemical Engineering, Aristotle University	Thessaloniki-Greece
17	Onsite	Asimopoulou	Andreana	Prof.	School of Chemical Engineering, Aristotle University	Thessaloniki-Greece
18	Onsite	Kazeli	Konstantina	PhD	MagnaCharta, Aristotle University	Thessaloniki-Greece
19	Onsite	Makridis	Antonios	Dr.	MagnaCharta, Aristotle University	Thessaloniki-Greece
20	Onsite	Nakas	Alexandros	PhD	School of Chemical Engineering, Aristotle University	Thessaloniki-Greece
21	Onsite	Samaras	Theodoros	Prof.	MagnaCharta, Aristotle University	Thessaloniki-Greece
22	Onsite	Angelakeris	Makis	Prof.	MagnaCharta, Aristotle University	Thessaloniki-Greece
23	Onsite	Asimakidou	Polina	PhD	School of Physics, Aristotle University	Thessaloniki-Greece
24	Onsite	Arampatzis	Athanasios	PhD	School of Chemical Engineering, Aristotle University	Thessaloniki-Greece
25	web	Dendrinou-Samara	Catherine	Prof.	School of Chemistry, Aristotle University	Thessaloniki-Greece
26	Onsite	Angelou	Konstantinos	PhD	School of Physics, Aristotle University	Thessaloniki-Greece
27	Onsite	Kasotakis	Manolis	BSc	School of Physics, Aristotle University	Thessaloniki-Greece
28	Onsite	Kouzoudis	Stavros	BSc	School of Physics, Aristotle University	Thessaloniki-Greece
29	Onsite	Tersis	Kristallis	BSc	School of Physics, Aristotle University	Thessaloniki-Greece
30	web	Litsardakis	George	Prof.	Faculty of Engineering, Aristotle University	Thessaloniki-Greece
31	web	Paloura	Eleni	Prof.	School of Physics, Aristotle University	Thessaloniki-Greece
32	Onsite	Sarafidis	Haris	Prof.	School of Physics, Aristotle University	Thessaloniki-Greece
33	Onsite	Katsikini	Maria	Prof.	School of Physics, Aristotle University	Thessaloniki-Greece
34	Onsite	Pinakidou	Fani	Dr.	School of Physics, Aristotle University	Thessaloniki-Greece
35	web	Sempros	George	PhD	School of Physics, Aristotle University	Thessaloniki-Greece
36	Onsite	Trigoniaris	Dimitris	BSc	School of Physics, Aristotle University	Thessaloniki-Greece
37	web	Natsiopoulos	George	PhD	School of Physics, Aristotle University	Thessaloniki-Greece
38	Onsite	Karagiannis	Iordanis	BSc	School of Physics, Aristotle University	Thessaloniki-Greece
39	Onsite	Nikidis	Stratos	MSc	School of Physics, Aristotle University	Thessaloniki-Greece
40	Onsite	Konstantinidis	Pavlos	MSc	School of Physics, Aristotle University	Thessaloniki-Greece
41	Onsite	Oikonomou	Aspa	MSc	School of Physics, Aristotle University	Thessaloniki-Greece
42	Onsite	Pourliaka	Anastasia	MSc	School of Physics, Aristotle University	Thessaloniki-Greece
43	Onsite	Tsompanoglou	Milan	BSc	School of Physics, Aristotle University	Thessaloniki-Greece
44	Onsite	Mpampouras	Apostolos	BSc	School of Physics, Aristotle University	Thessaloniki-Greece
45	web	Chrysafi	Iouliana	PhD	School of Physics, Aristotle University	Thessaloniki-Greece
46	web	Kiriakou-Tziamtzi	Christina	PhD	School of Physics, Aristotle University	Thessaloniki-Greece
47	web	Rountou	Rafalia	MSc	School of Physics, Aristotle University	Thessaloniki-Greece
48	web	Taksintari	Athina	MSc	School of Physics, Aristotle University	Thessaloniki-Greece
49	web	Kalpetis	Dimitris	MSc	School of Physics, Aristotle University	Thessaloniki-Greece
50	Onsite	Manoloudis	Pavlos	MSc	School of Physics, Aristotle University	Thessaloniki-Greece
51	web	Carvou	Nicolas	Dr.	MagneticInsight	UK
52	web	Tapas	Sen	Prof.	University of Lancanshire	
53	web	Chlichlia	Catherine	Prof.	Dept. of Molecular Biology & Genetics, Democritus University	Alexandroupolis-Greece

Num	Onsite-web	Surname	FirstName	Title	Affiliation01	City-Country
54	web	Spiridopoulou	Katerina	Dr.	Dept. of Molecular Biology & Genetics, Democritus University	Alexandroupolis-Greece
55	web	Manukyan	Aram	Prof.	Institute for Physical Research, National Academy of Sciences	Ashtarak, Armenia
56	web	Chilingaryan	Gayane	PhD	Institute for Physical Research, National Academy of Sciences	Ashtarak, Armenia
57	web	Gyulasaryan	Harutyun	PhD	Institute for Physical Research, National Academy of Sciences	Ashtarak, Armenia
58	web	Spirou	Spiridon	Dr.	Department of Radiology, Sismanoglio General Hospital of Attica	Athens- Greece
59	web	Trohidou	Kalliopi	Dr.	NCSR "Demokritos"	Athens-Greece
60	web	Vergnaud	Florestan	PhD	SIGMA Clermont, Campus des Cézeaux	Aubière-France
61	web	Brandon	Giles	MSc.	Intelligentsia Consultants	Bertrange-Luxembourg
62	Onsite	van Oossanen	Rogier	PhD	Erasmus University Medical Center & Delft University of Technology	Delft-Netherlands
63	Onsite	Maier	Alexandra	PhD	Delft University of Technology	Delft-Netherlands
64	web	Farle	Michael	Prof.	Fakultät für Physik, Universität Duisburg-Essen	Duisburg-Germany
65	web	Spasova	Marina	Dr.	Fakultät für Physik, Universität Duisburg-Essen	Duisburg-Germany
66	web	Wiedwald	Ulf	Prof.	Fakultät für Physik, Universität Duisburg-Essen	Duisburg-Germany
67	web	Semisalova	Anna	Dr.	Fakultät für Physik, Universität Duisburg-Essen	Duisburg-Germany
68	Onsite	Papadopoulou	Elisavet	MSc	Fakultät für Physik, Universität Duisburg-Essen	Duisburg-Germany
69	Onsite	Tetos	Nikolaos	MSc	Fakultät für Physik, Universität Duisburg-Essen	Duisburg-Germany
70	web	Feggeler	Thomas	PhD	Fakultät für Physik, Universität Duisburg-Essen	Duisburg-Germany
71	web	Li	Jianing	PhD	Department of Applied Physics, Eindhoven University of Technology	Eindhoven-Netherlands
72	web	Kalpaxidou	Zoi	PhD	ASLM	Eindhoven-Netherlands
73	web	Hoffman	Ulrich	Prof.	Medical Center, University of Freiburg	Freiburg-Germany
74	web	Buchholz	Oliver	PhD	University Hospital Freiburg	Freiburg-Germany
75	Onsite	Batakis	Leonidas	BSc	School of Physics, University of Ioannina	Ioannina-Greece
76	Onsite	Eksakoustou	Argiro	BSc	School of Physics, University of Ioannina	Ioannina-Greece
77	web	Abakumov	Maxim	Dr.	Russian National Research Medical University, NUST MISIS	Moscow-Russia
78	web	Efremova	Maria	Dr.	Depa. of Nuclear Medicine, TUM School of Medicine, Technical University	Munich-Germany