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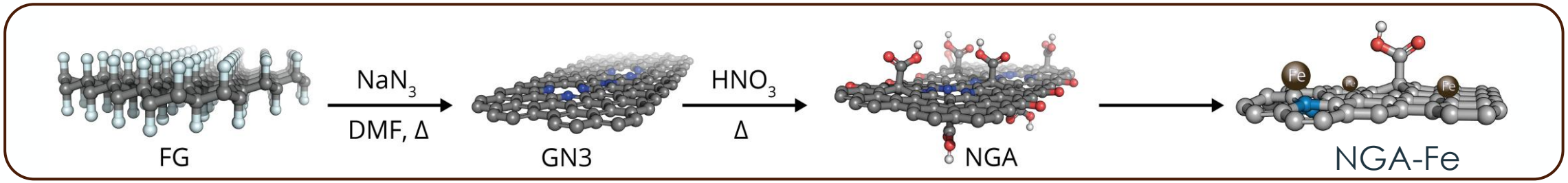
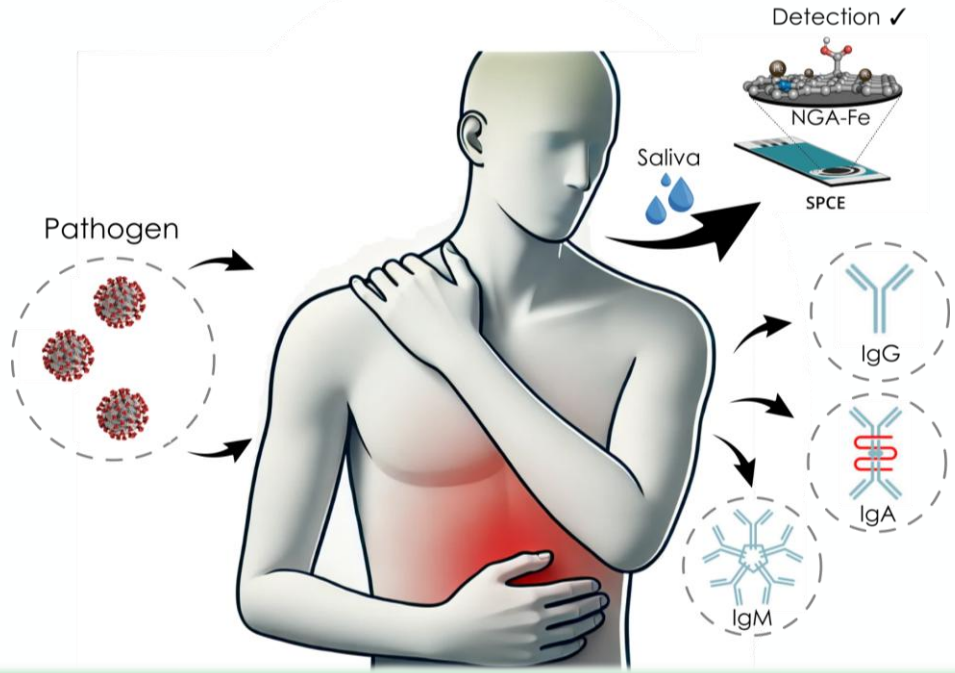
Palacký University Olomouc

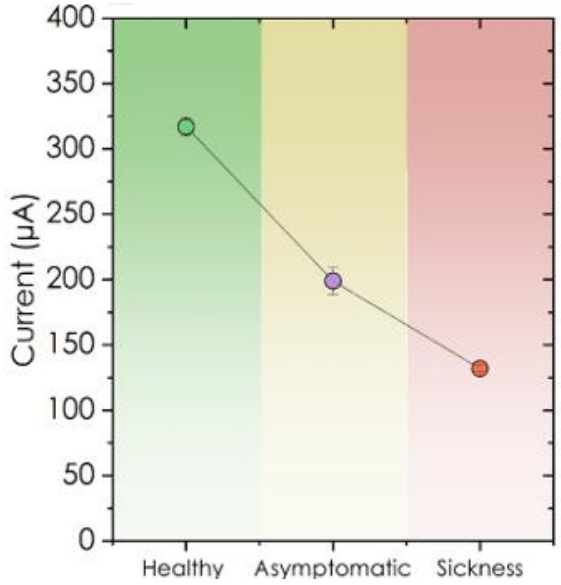
A Novel Biosensing Mechanism Based on Single-Atom Engineering for Rapid Detection of Antibodies

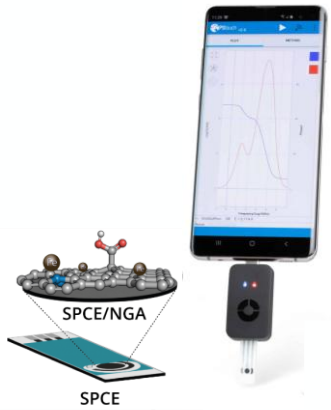
Ivan Dědek 25.03.25

Nitrogen-doped graphene acid + Fe (NGA-Fe)









Saliva → Incubation with NGA-Fe (1 h) → Purification (1 h) → Drop-cast/drying (20 min) → Detection (5 min)

Result < 3 h ✓

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The work was supported from ERDF/ESF project TECHSCALE (No. CZ.02.01.01/00/22_008/0004587).

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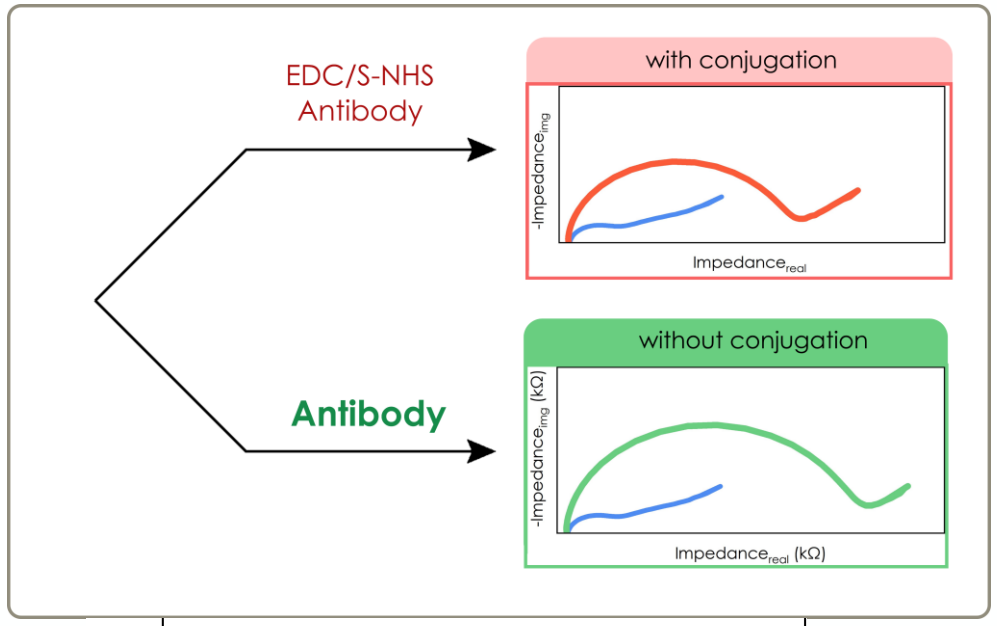
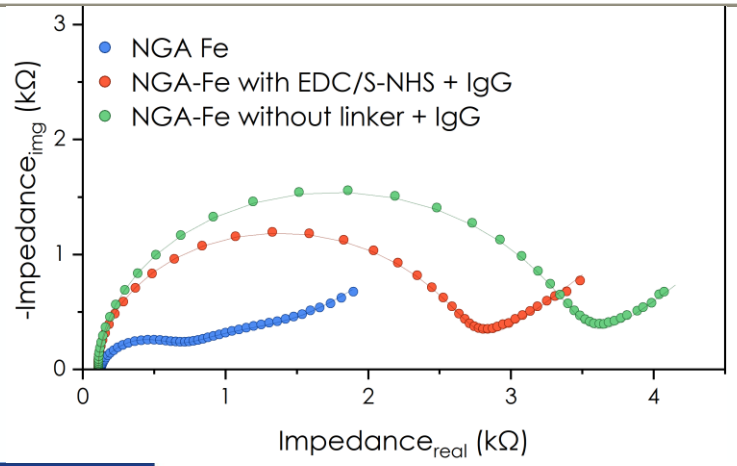
Eliminating the need for linkers. Omitting EDC/S-NHS chemistry





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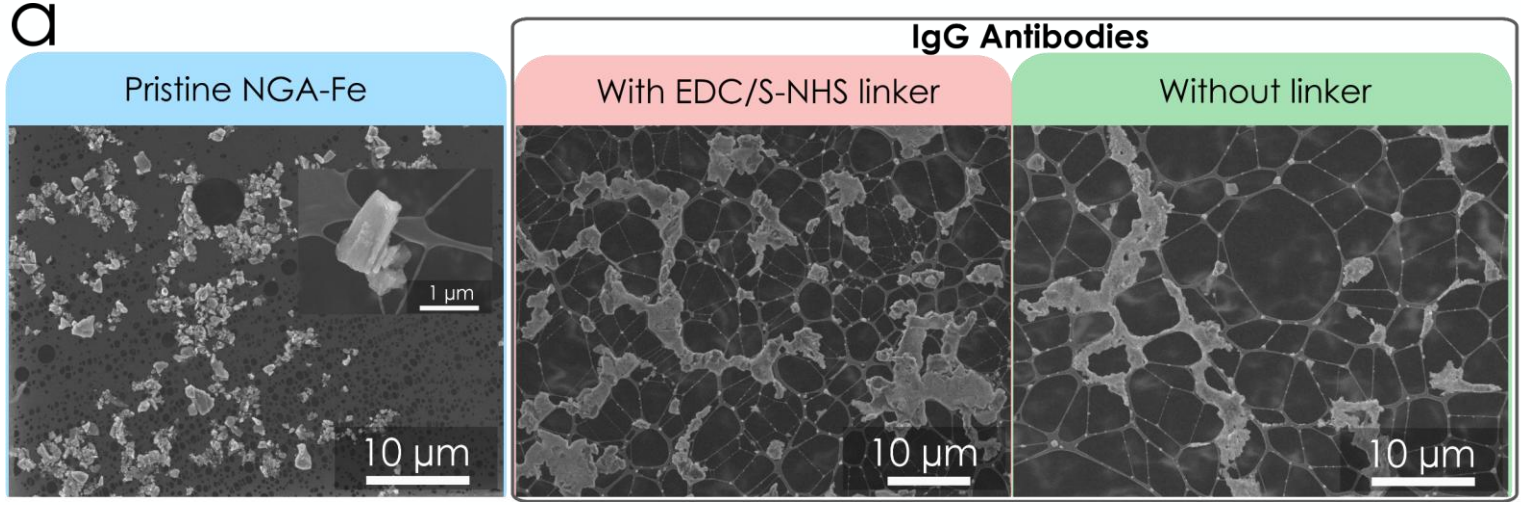

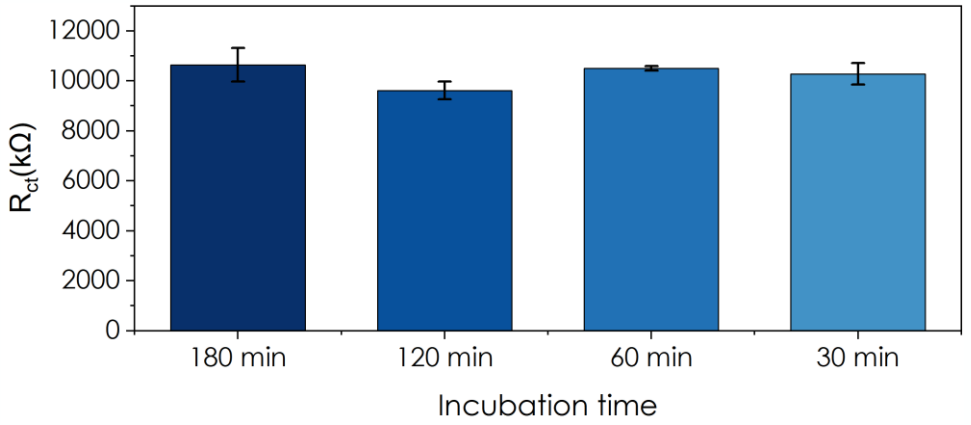

- Reduced complexity and cost

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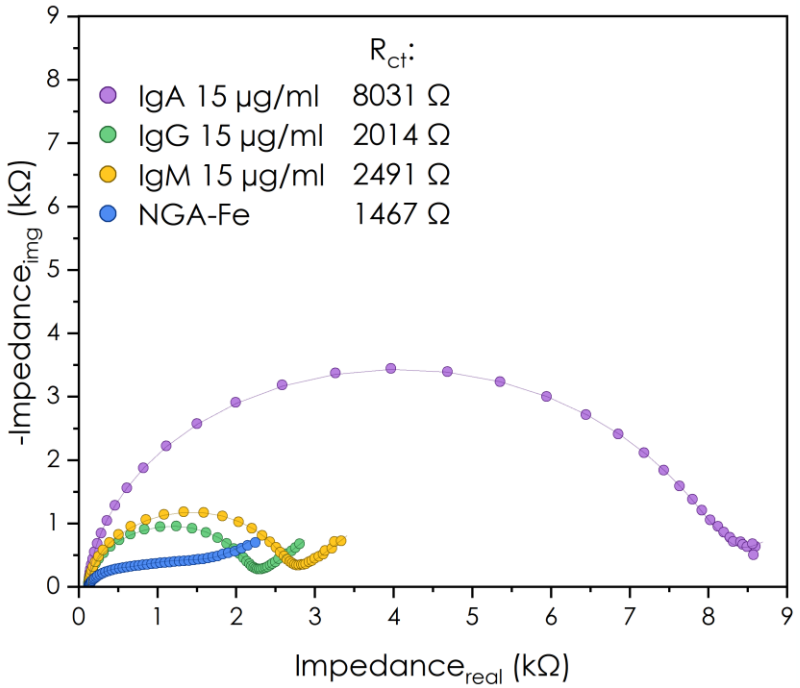
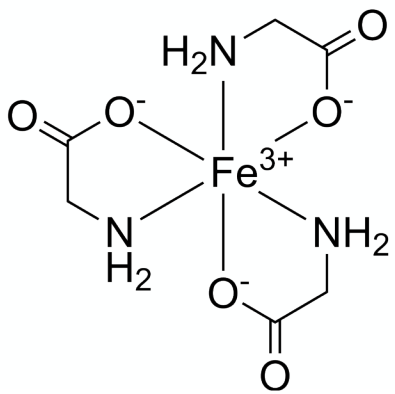
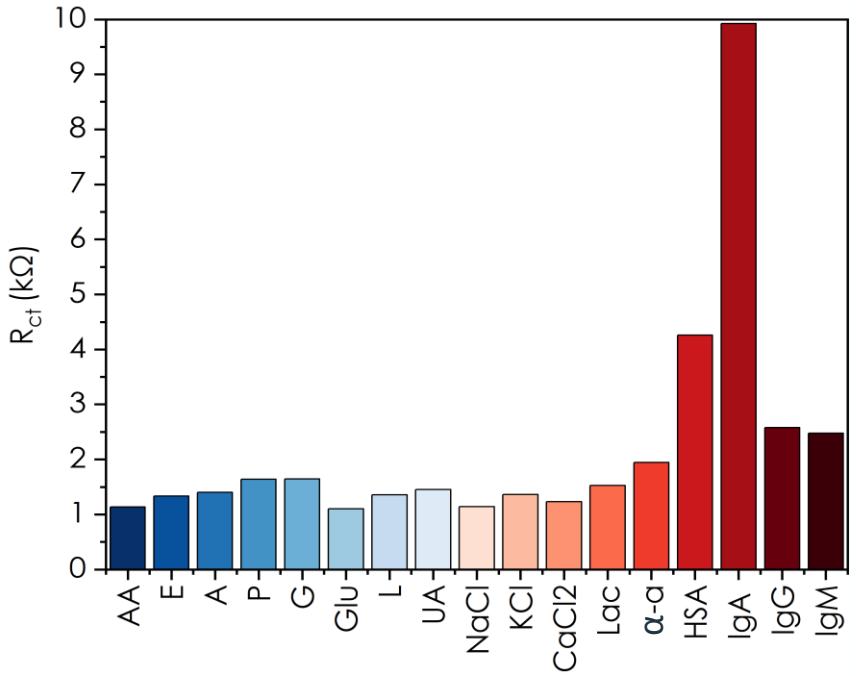
Individual antibodies response | Interference?







*Physiological concentration

ascorbic acid (AA)
glutamic acid (E)
alanine (A)
proline (P)
glycine (G)
glucose (Glu)
lactate (L)
uric acid (UA)
NaCl, KCl, and $CaCl_2$
lactoferrin (Lac)
a-amylase (a-A)
human serum albumin (HAS)
antibodies (IgA, IgG, IgM)

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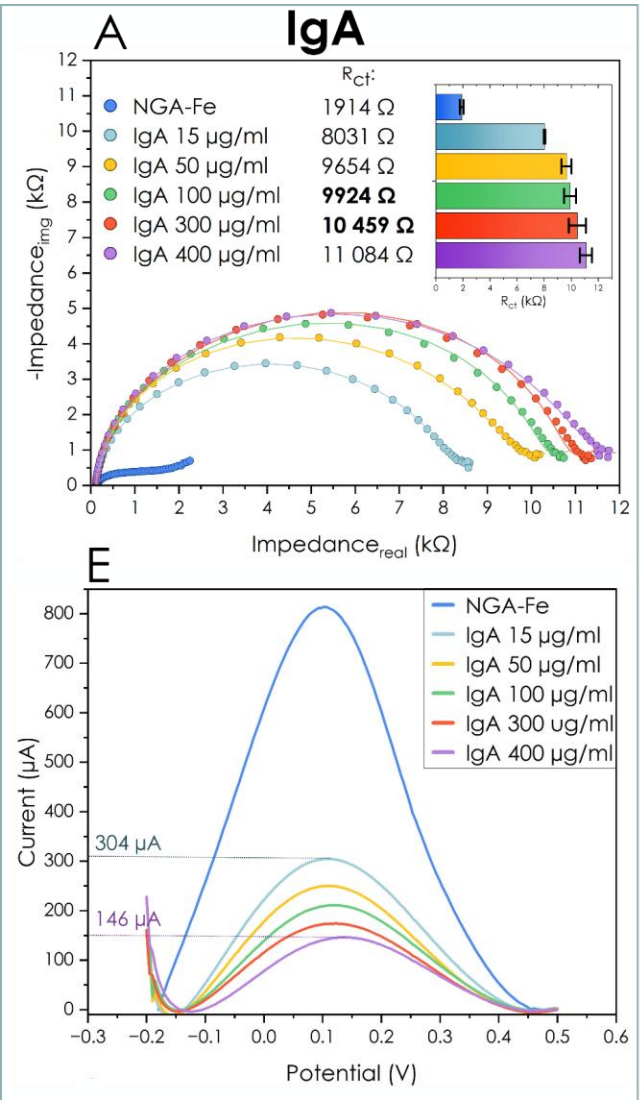
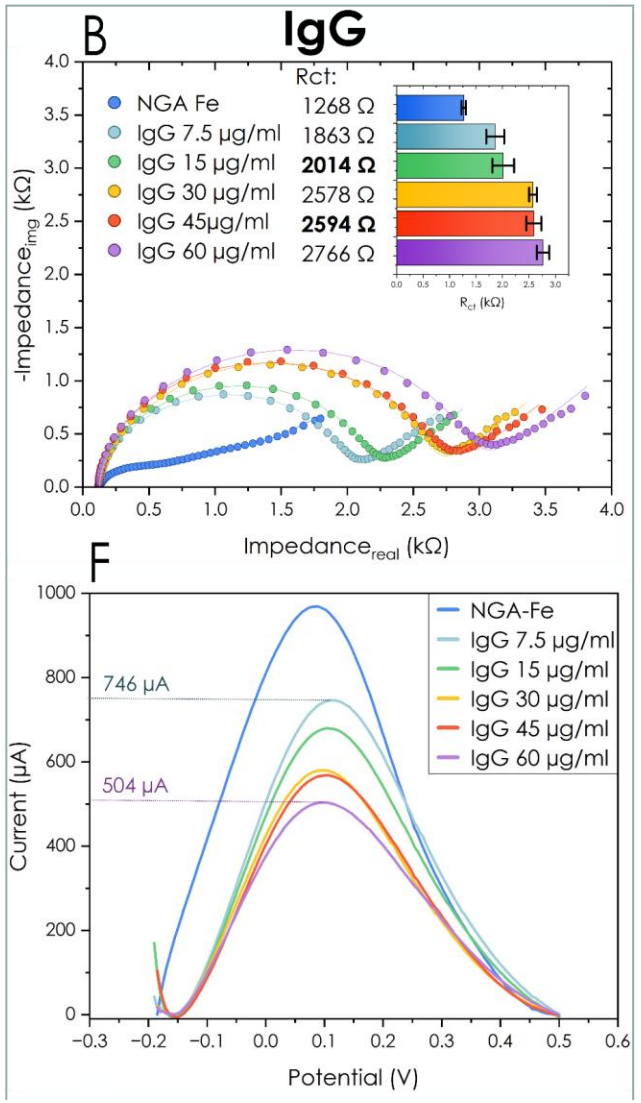
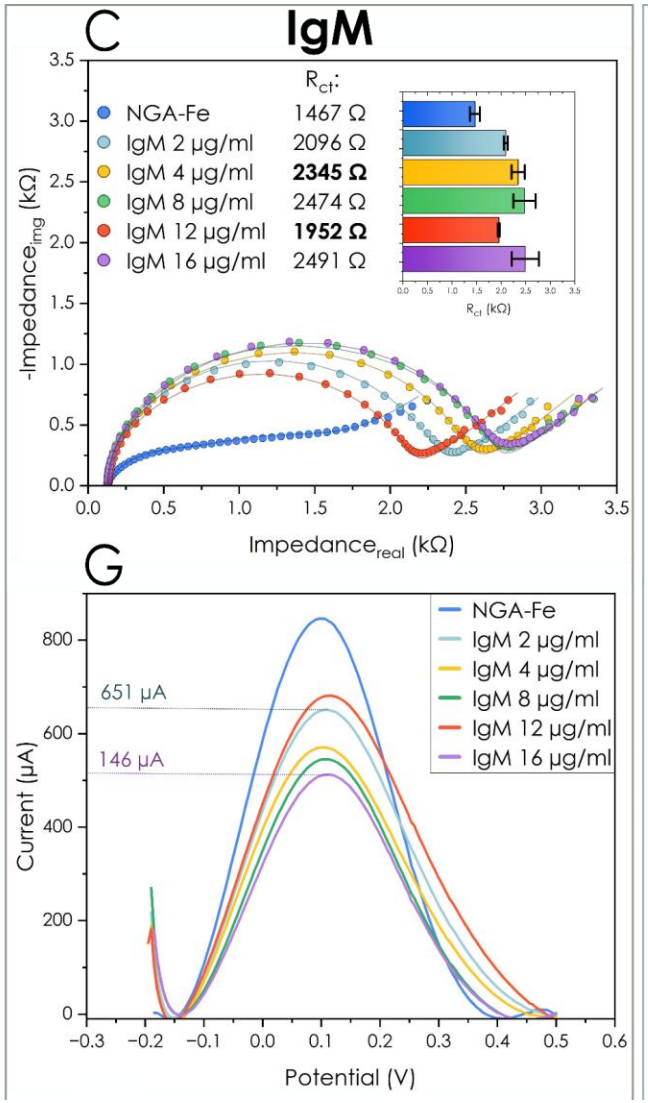
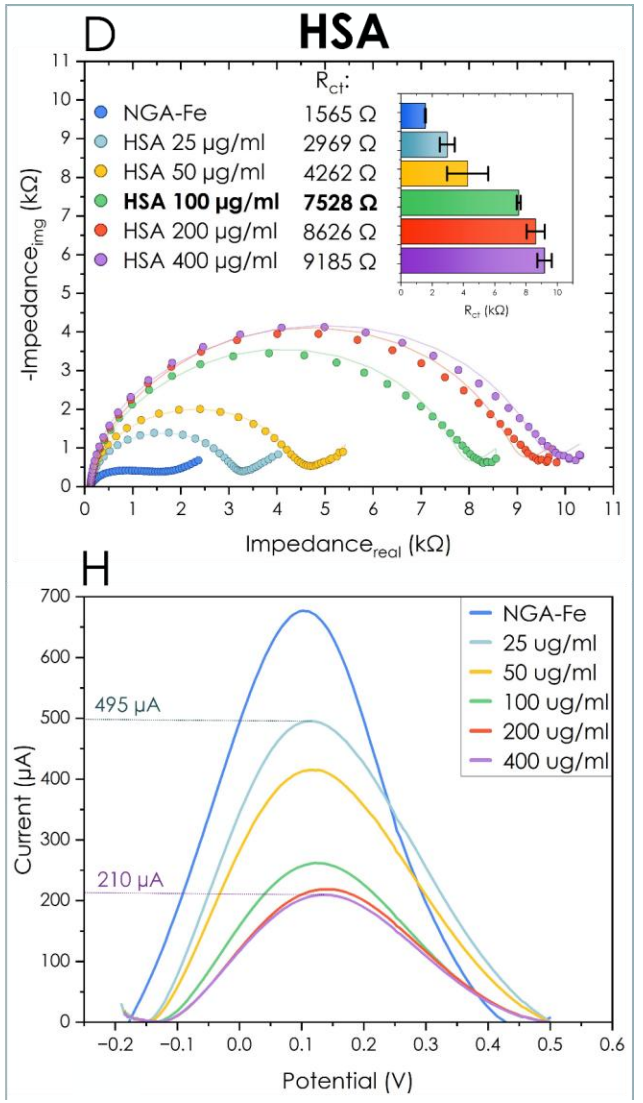
Individual antibobies + HSA









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Mixture – Healthy and ill levels

Table 1. Physiologically relevant levels in saliva

Mixture	IgA (μg ml^{-1})	IgG (μg ml^{-1})	IgM (μg ml^{-1})	HSA (μg ml^{-1})	α-amylase (μg ml^{-1})
Healthy levels	100	15	4	50	200
Elevated antibodies	300	45	12	100	100
Elevated HSA	100	15	4	200	100
High levels	300	45	12	200	400

Table 2. Achieved assay

Analyte	Dynamic range	Limit of detection	Sensitivity
IgA (390 kDA)	38.5 nM – 1.03 μM (15 μg ml^{-1} – 400 μg ml^{-1})	0.38 μg ml^{-1} (0.97 nM)	6,220 kΩ nM^{-1} cm^{-2}
IgG (160 kDA)	46.9 nM – 375 nM (7.5 μg ml^{-1} – 60 μg ml^{-1})	0.23 μg ml^{-1} (1.44 nM)	1,270 kΩ nM^{-1} cm^{-2}
IgM (970 kDA)	2.06 nM – 16.5 nM (2 μg ml^{-1} – 6 μg ml^{-1})	1.42 μg ml^{-1} (1.46 nM)	3,190 kΩ nM^{-1} cm^{-2}
HSA (66.5 kDA)	376 nM – 6 μM (25 μg ml^{-1} – 400 μg ml^{-1})	0.03 μg ml^{-1} (0.45 nM)	2,960 kΩ nM^{-1} cm^{-2}

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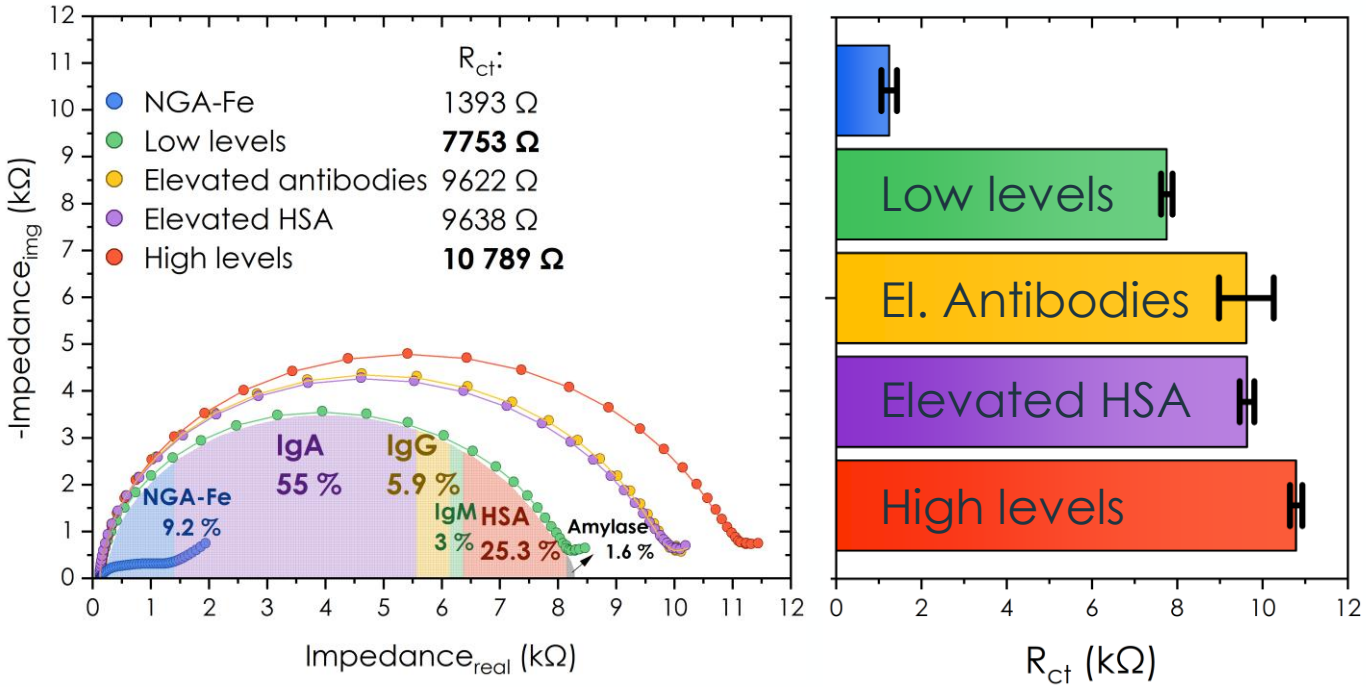
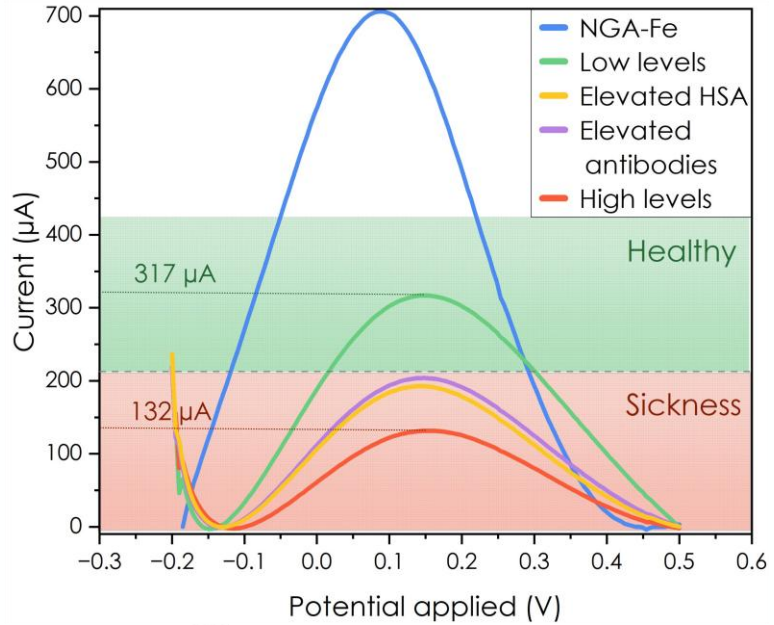
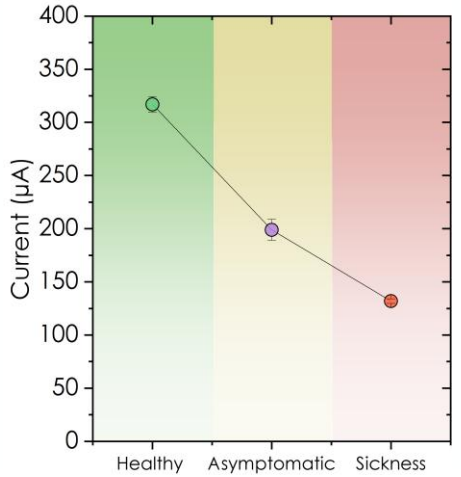
Mixture – Healthy and ill levels







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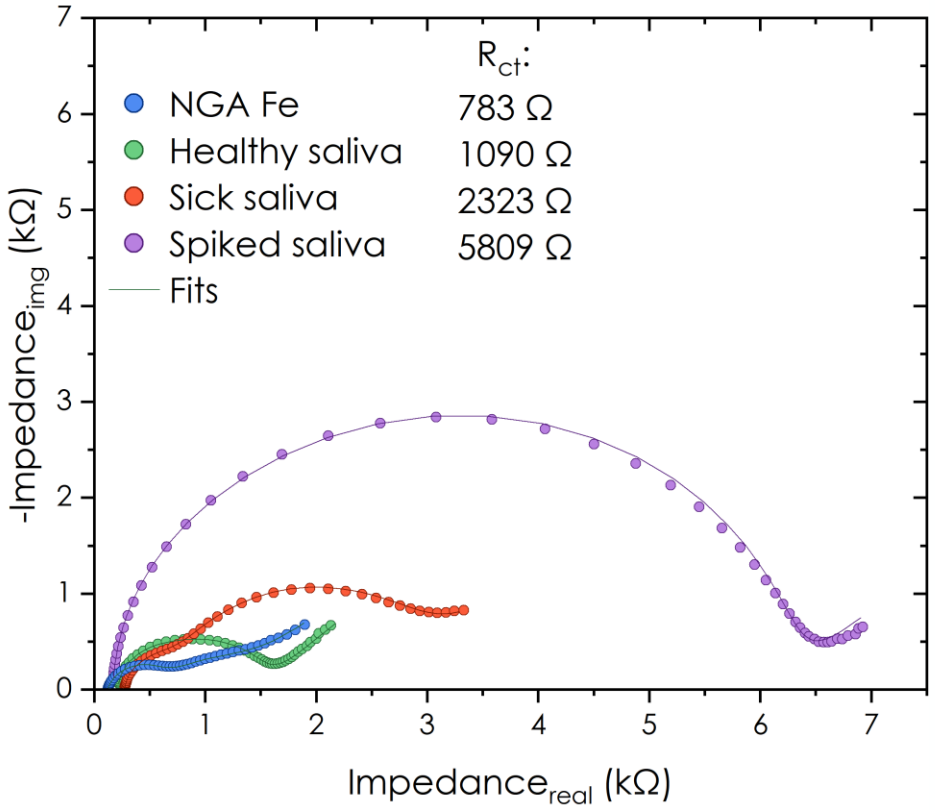
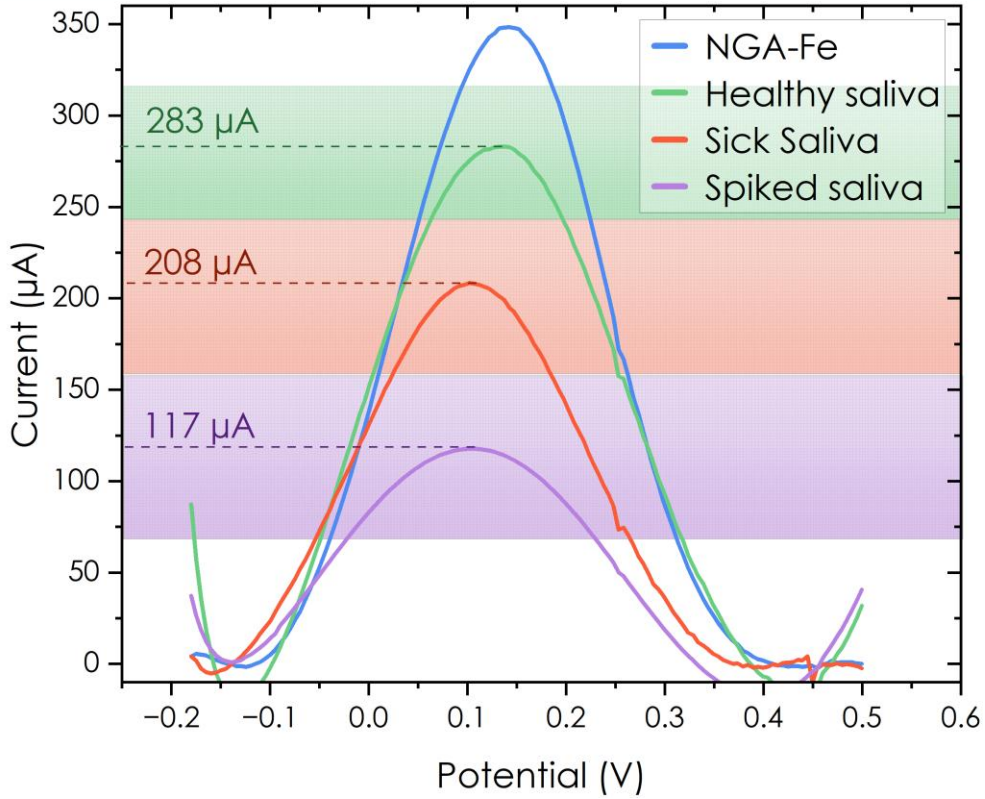
Real saliva





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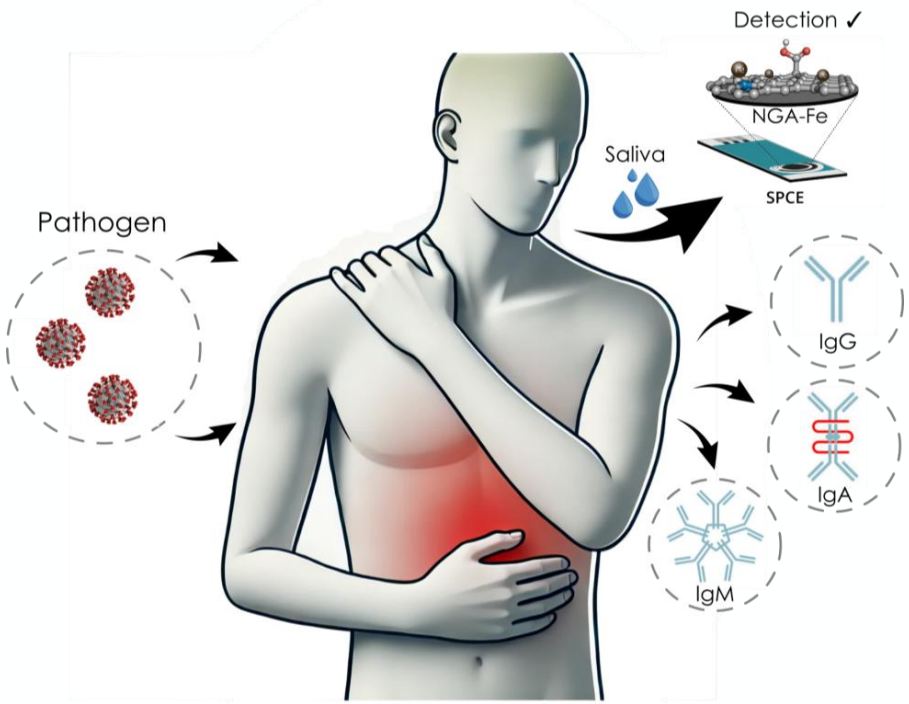
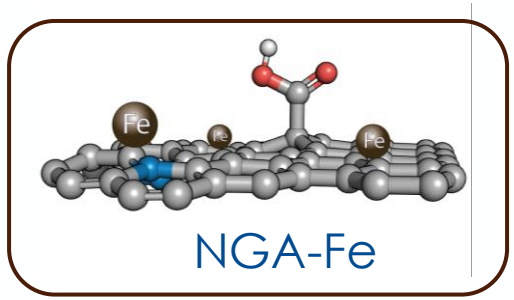
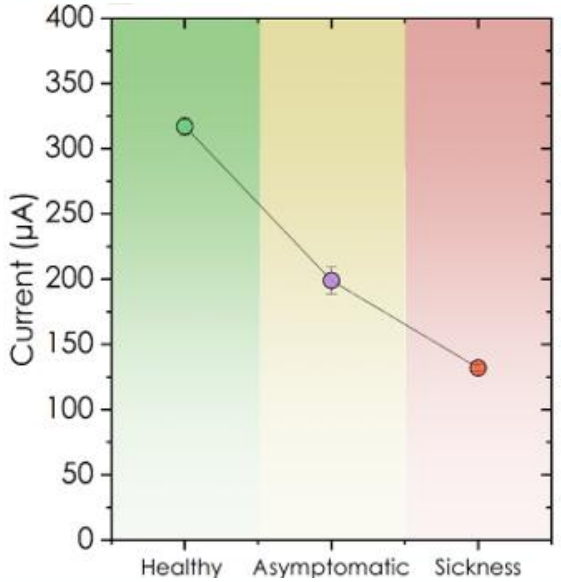
Conclusion







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Result < 3 h ✓

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Thank you
Q&A

RCPTM

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