Perspective pentru un nou biocatod de potențial ridicat – noi proprietăți ale enzimelor redox imobilizate pe nanostructuri compozite de grafit

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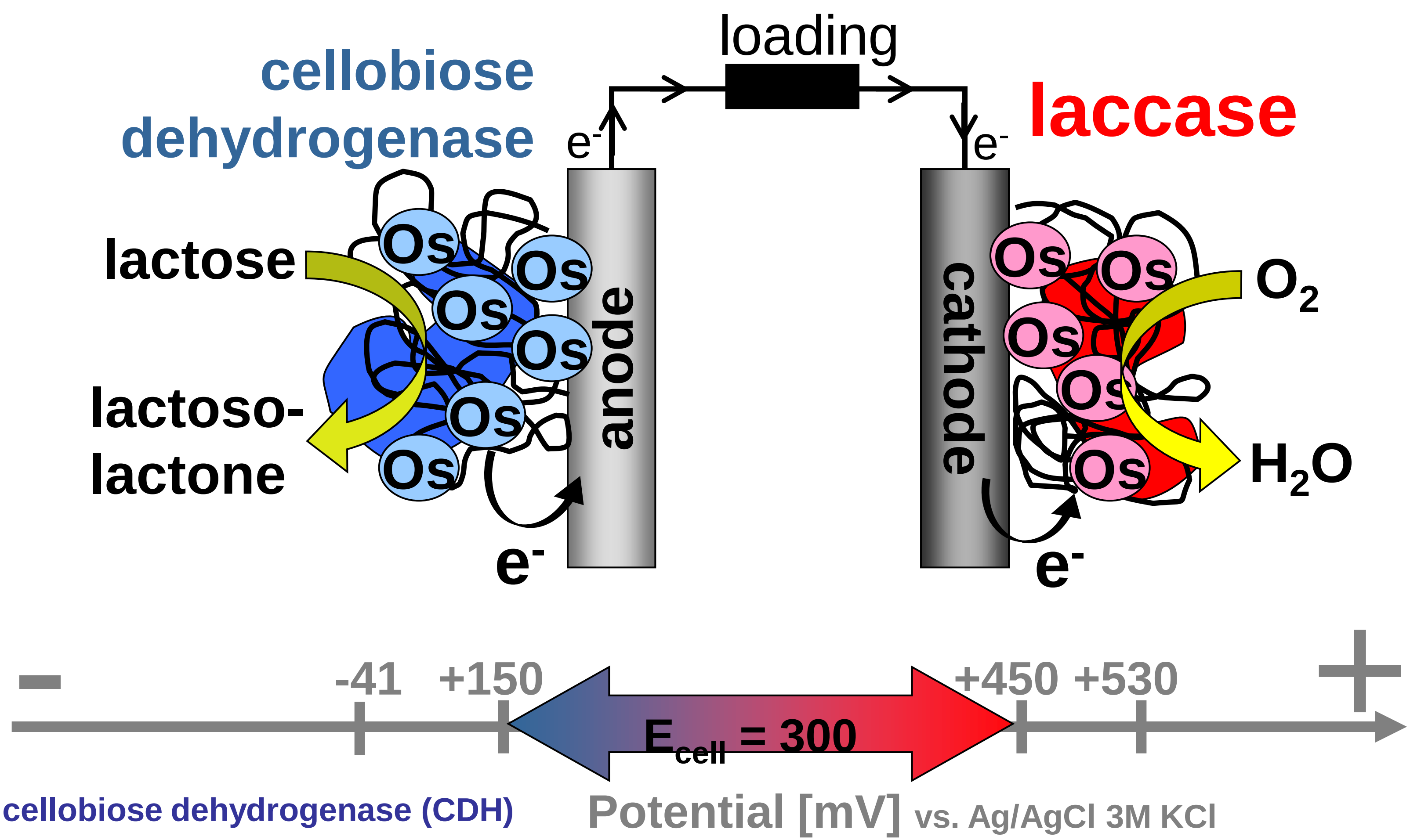
Concept of bienzymatic membrane-less biofuel cell (BFC)



cellobiose dehydrogenase (CDH)

laccase

Stoica L. et al, **Fuel Cells** (2009), 9 (1), 53-62

Motivation for new material electrode

- High catalytic coverage:
  - large amount of **active enzyme**;
- Large **active** area of electrode:
  - using hierarchical carboneous materials two-generations CNT's
- Exploring specific properties of **bio-nano** interactions.

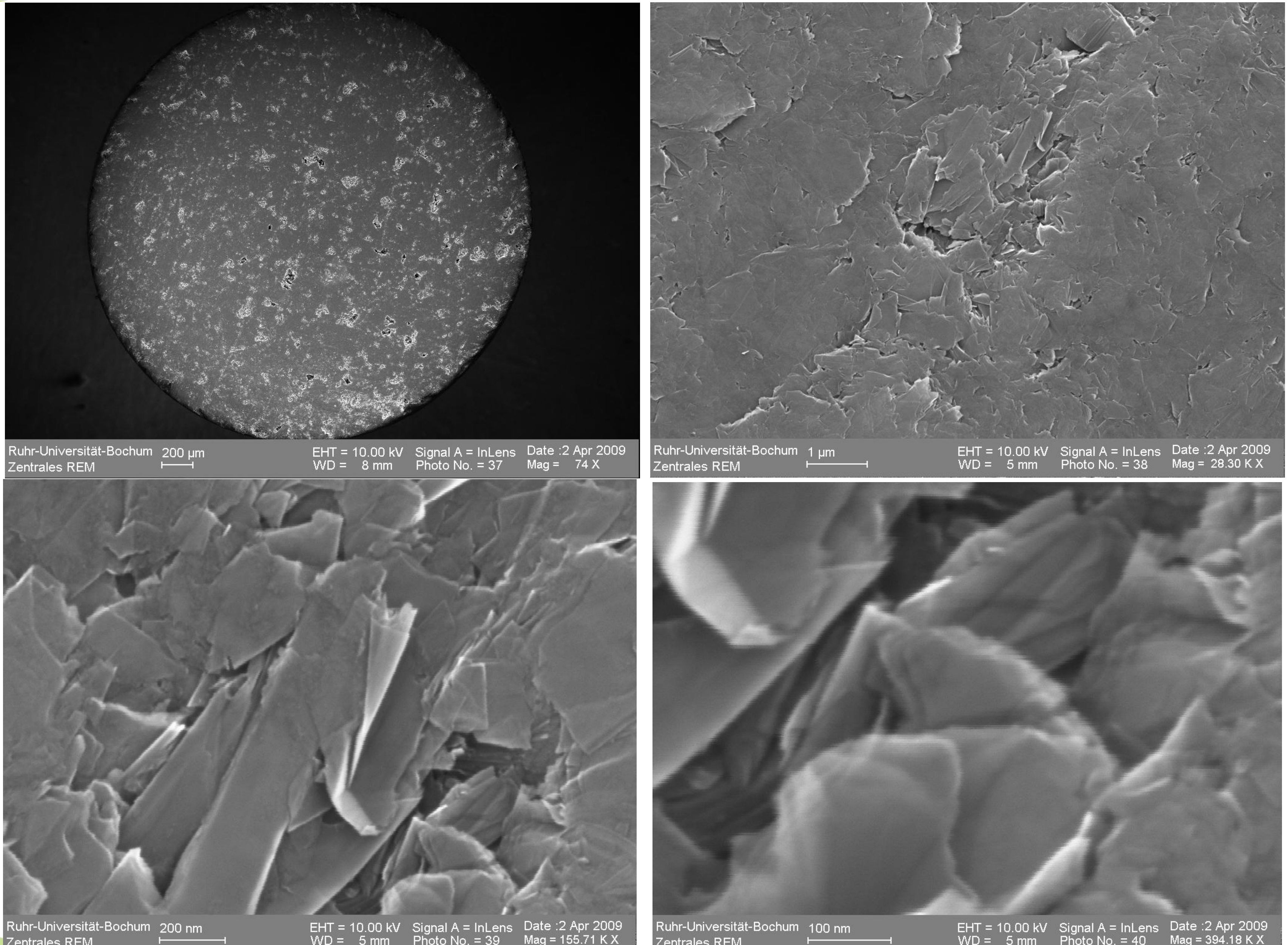
[E]; A; k_{cat}, n

$$P_{out} = E \times I$$

$E^{0'}$

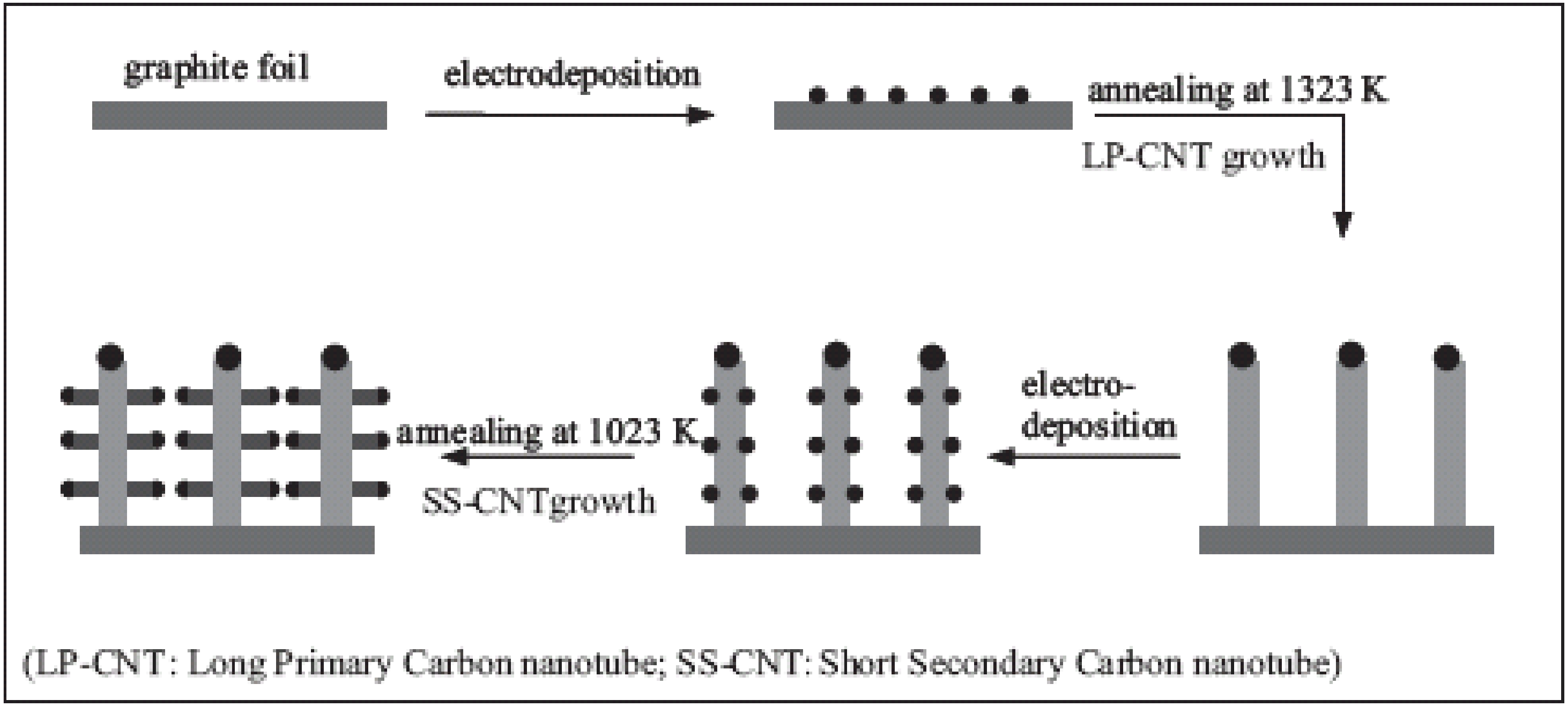
I. Large active area electrode

Graphite electrode surface



Composite material: CNT/CMF onto carbon paper

Preparation:



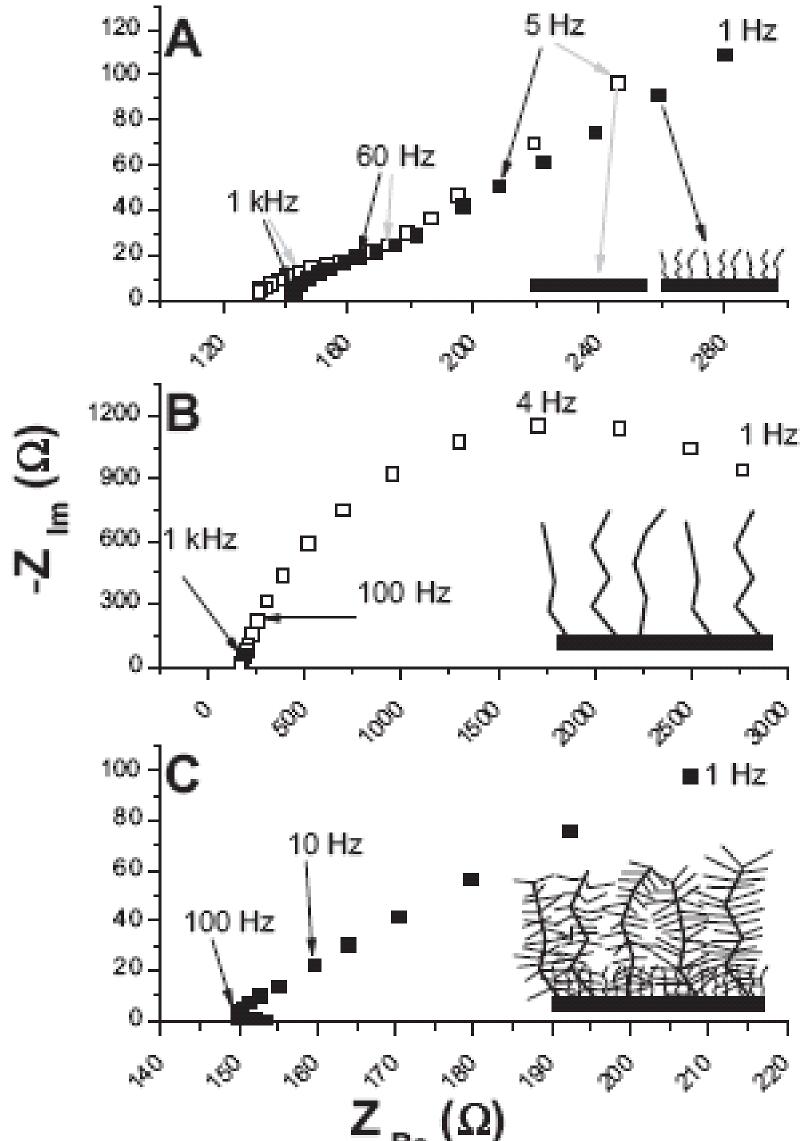
N. Li, X. Chen, L. Stoica, W. Xia, J. Qian, J. Aßmann, W. Schuhmann, M. Muhler

Adv. Mater. (2007), 19, 2957-2960

EIS characterisation of CNT/CMF

Properties:

- Low ohmic resistance => no potential loss;
- Ratio active/geometric area=200;
- Non-restrictive diffusion of enzyme substrate.



N. Li, X. Chen, L. Stoica, W. Xia, J. Qian, J. Aßmann, W. Schuhmann, M. Muhler
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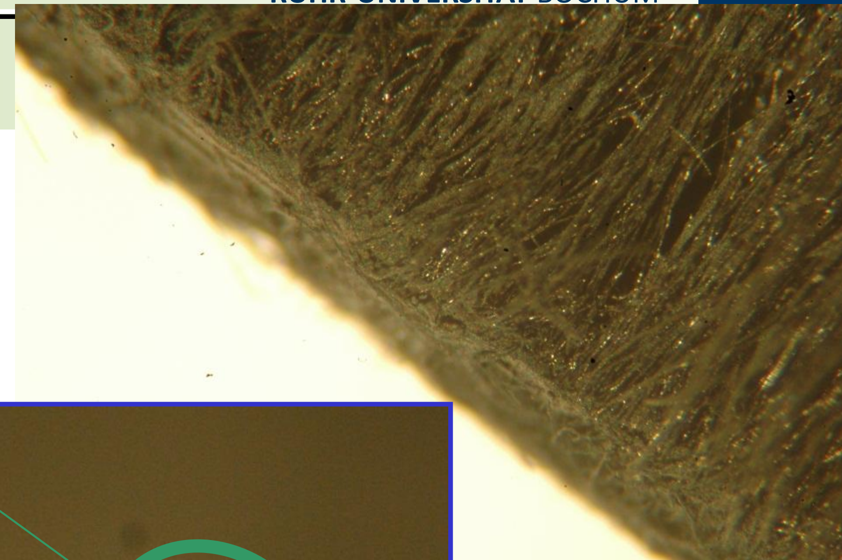
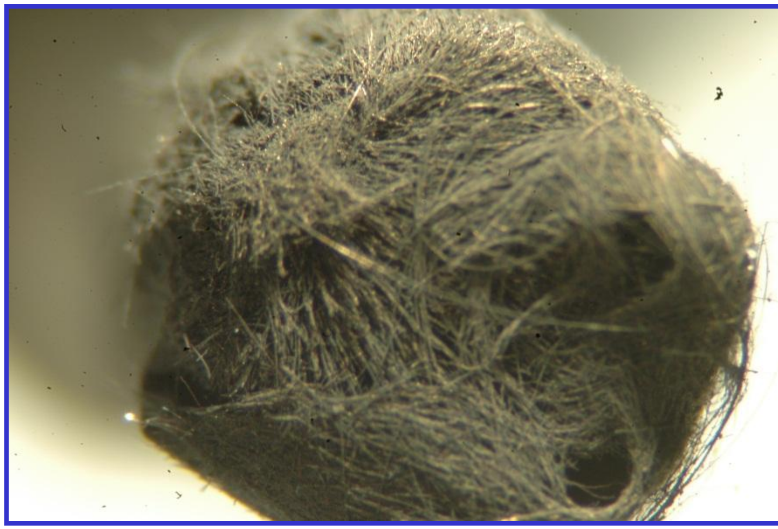
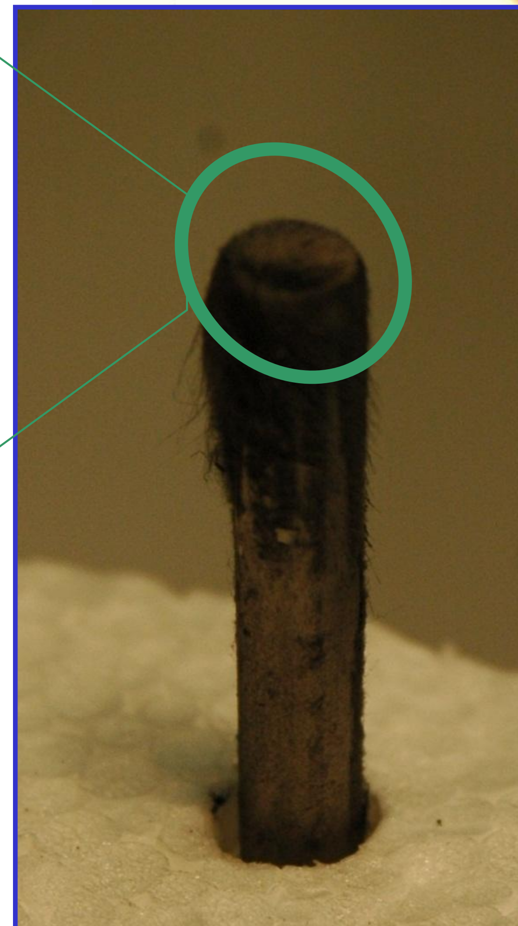
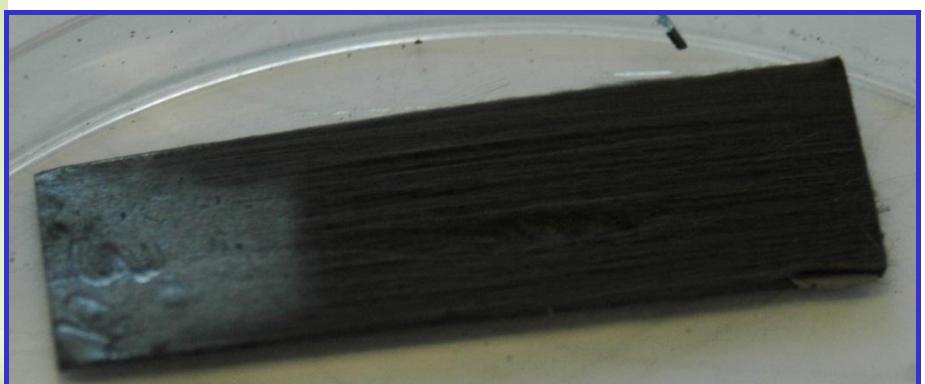
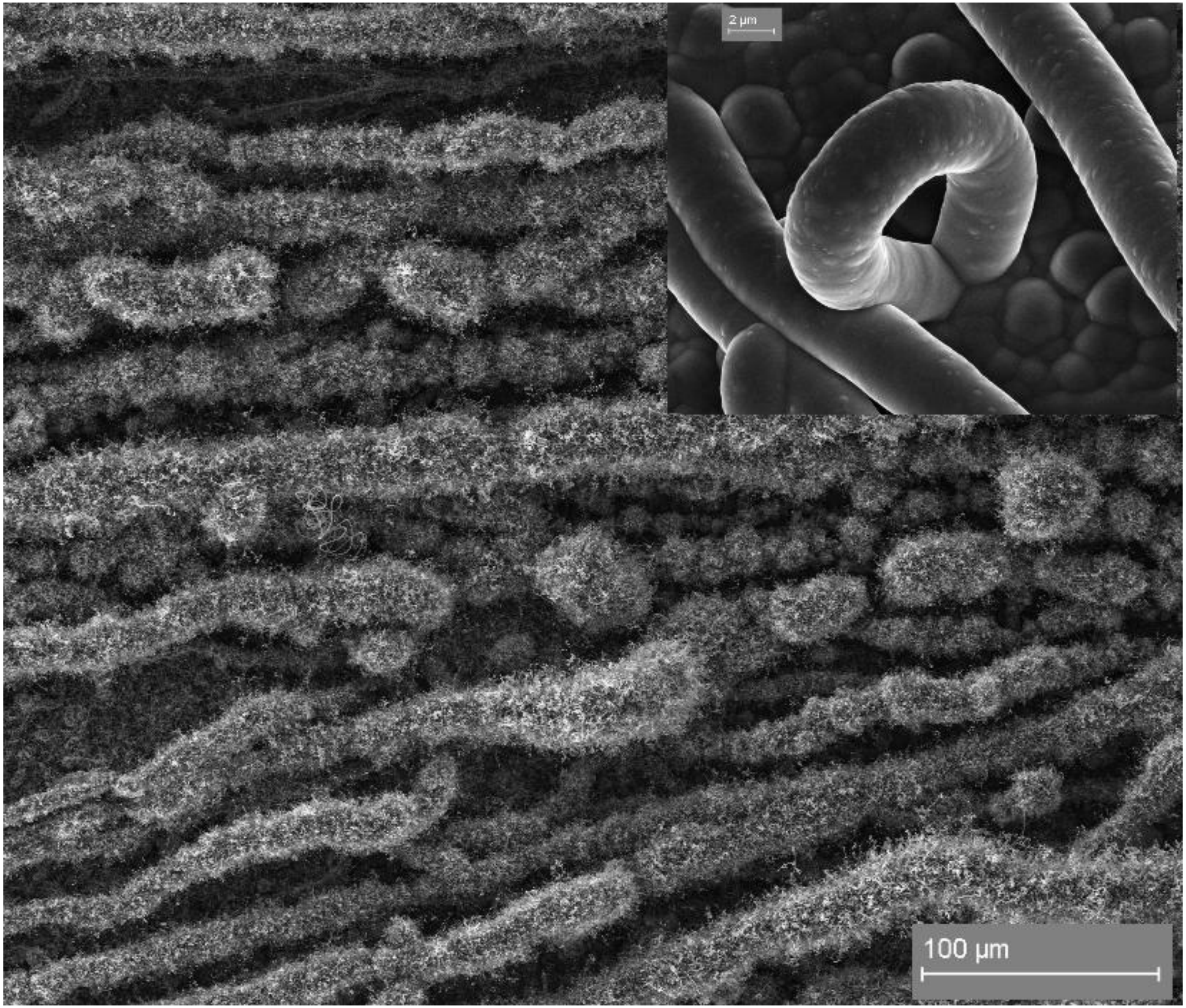
Various supports







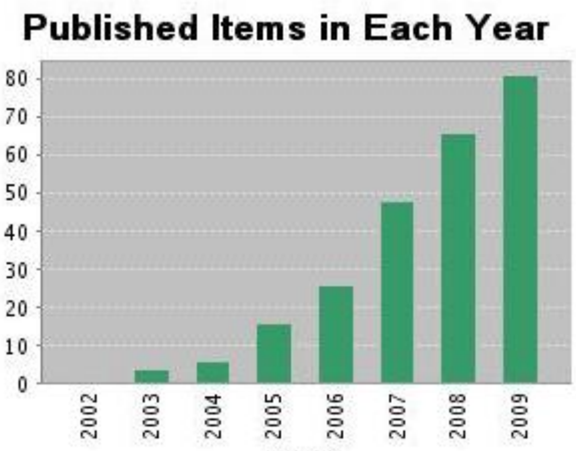


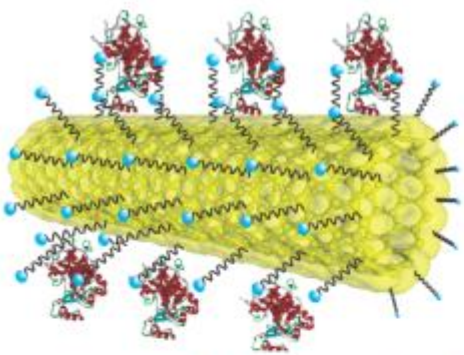

2 µm
100 µm

II. Exploring specific bio-nano interactions

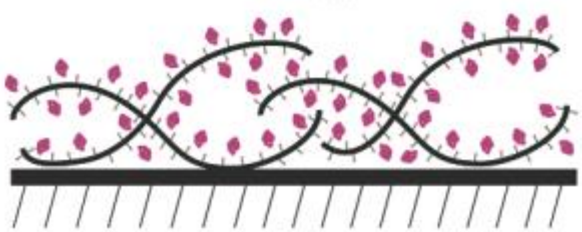
HRP-CNT

250 results



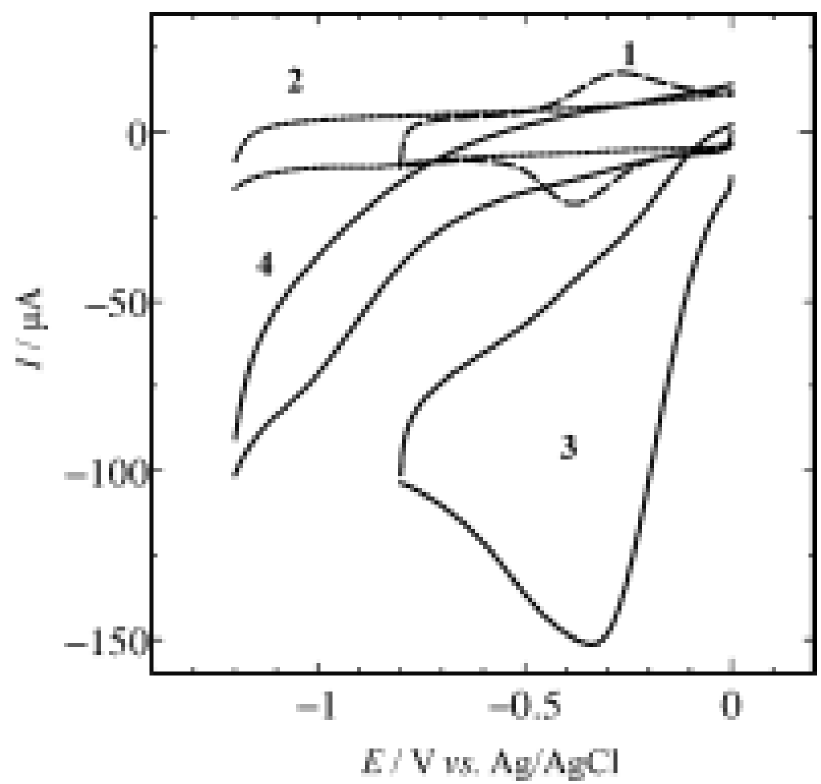


A

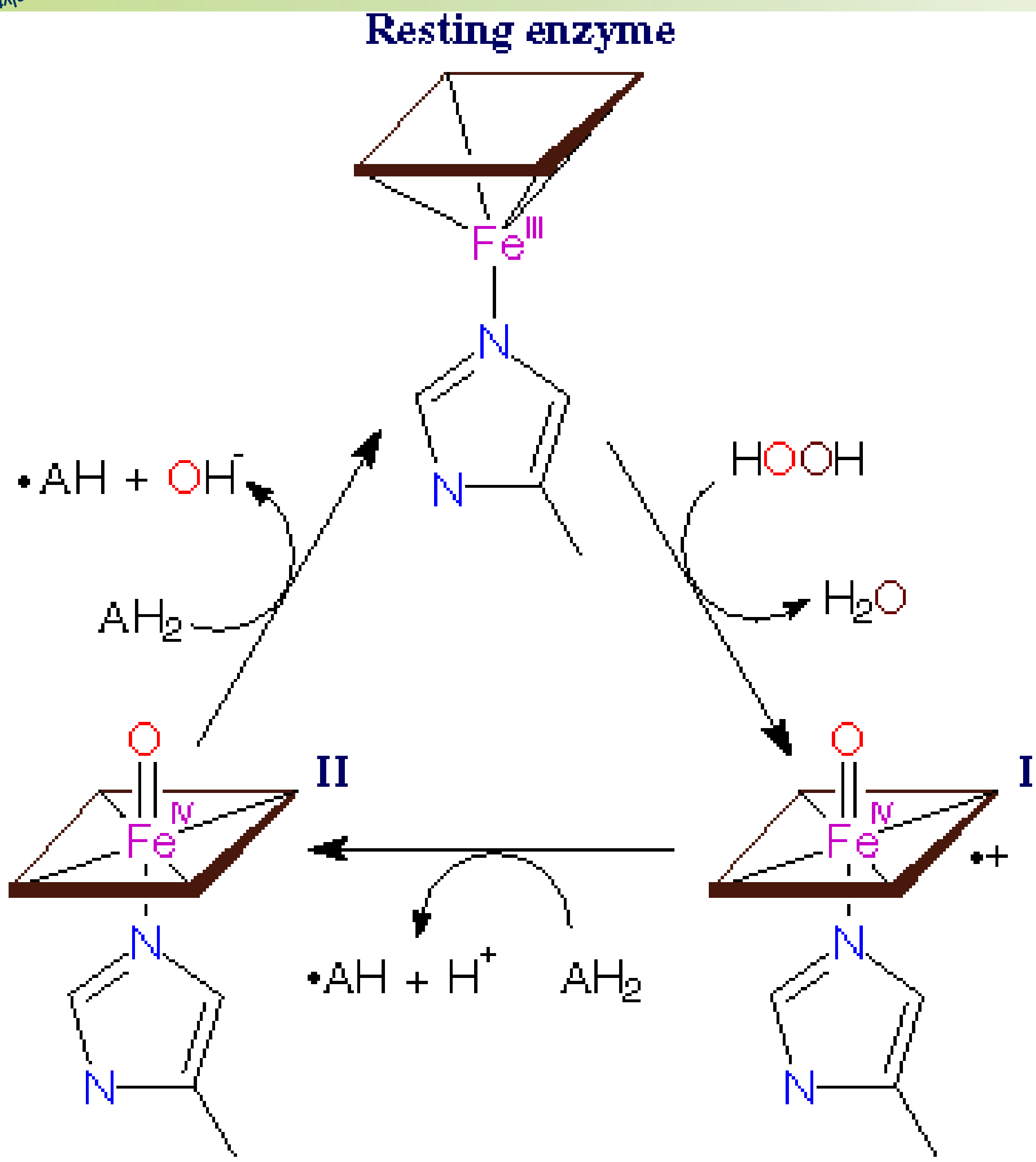


B

...only at low potentials!!



Y. Yan et al., Langmuir 2005, 21, 6560-6566



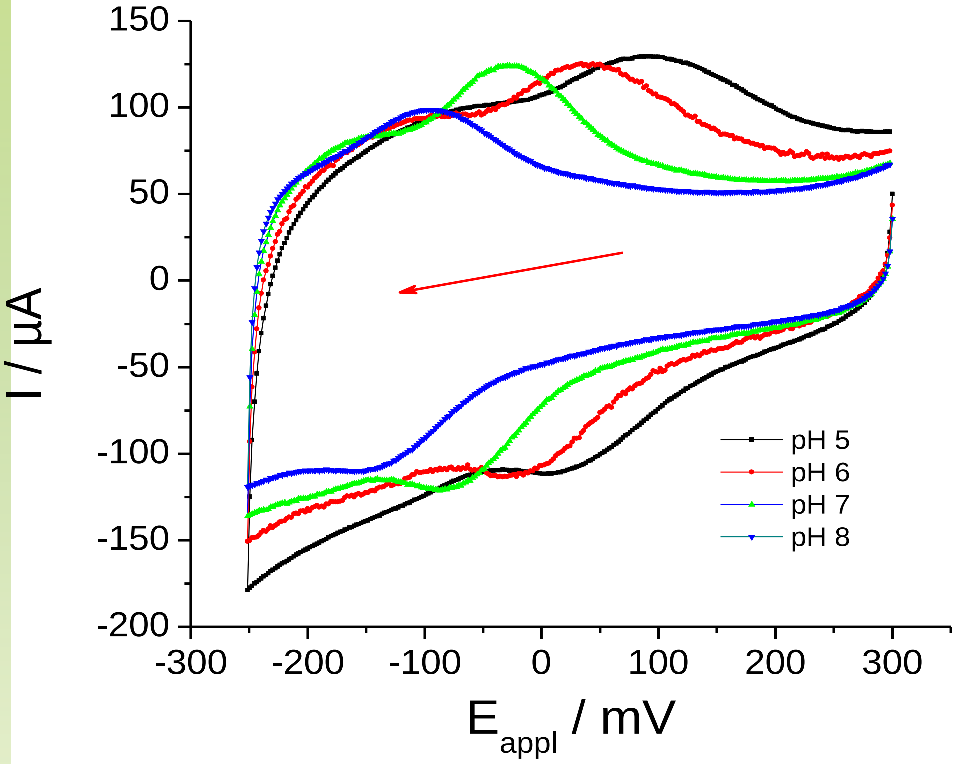
Thermodynamic potential for reduction = +750 mV

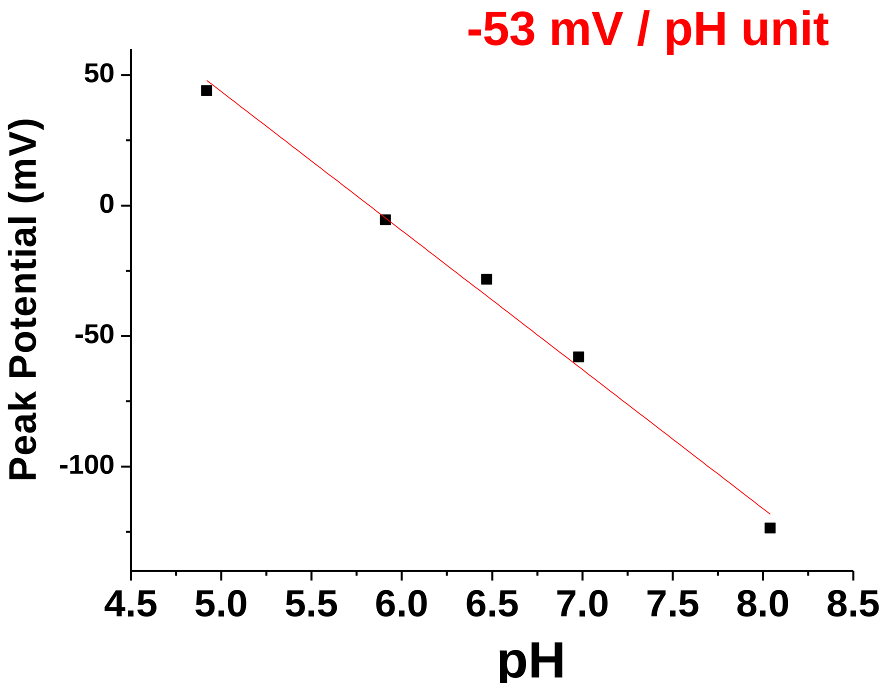
Any

specific bioelectrochemistry of HRP

@ these new materials?

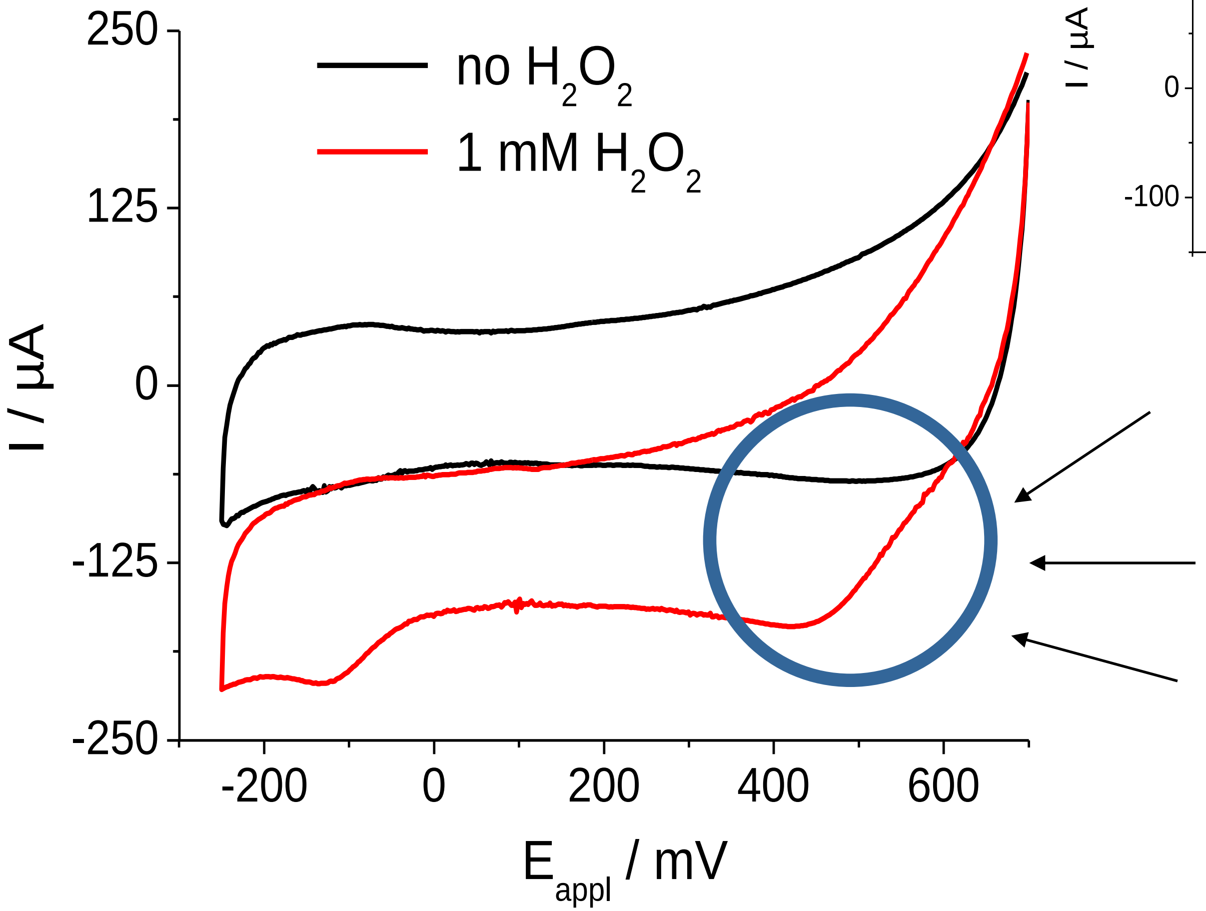
Bioelectrochemistry of HRP-heme

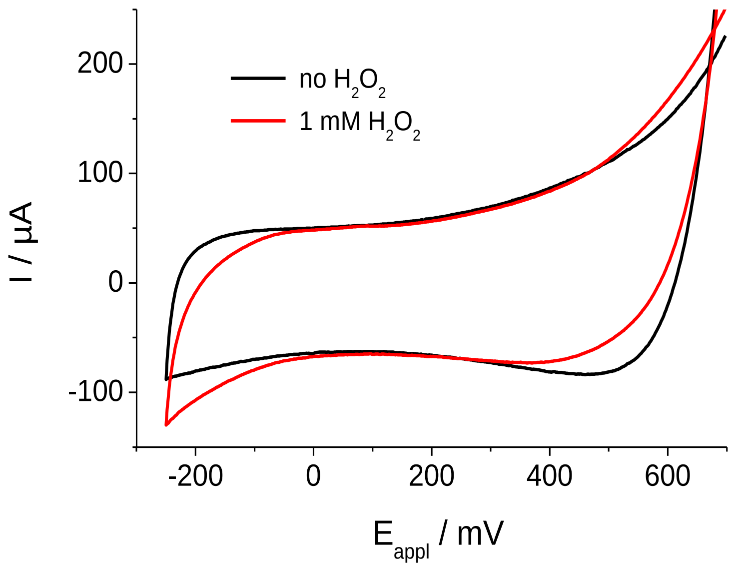




PHA - pyrene-hexanoic acid

Bioelectrocatalytic current for H_2O_2 reduction at +600 mV

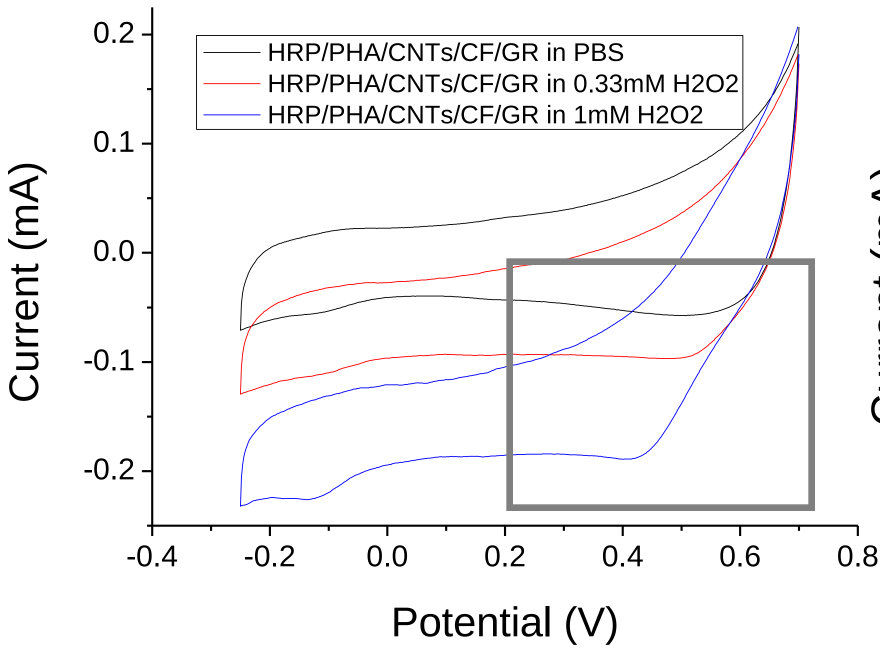


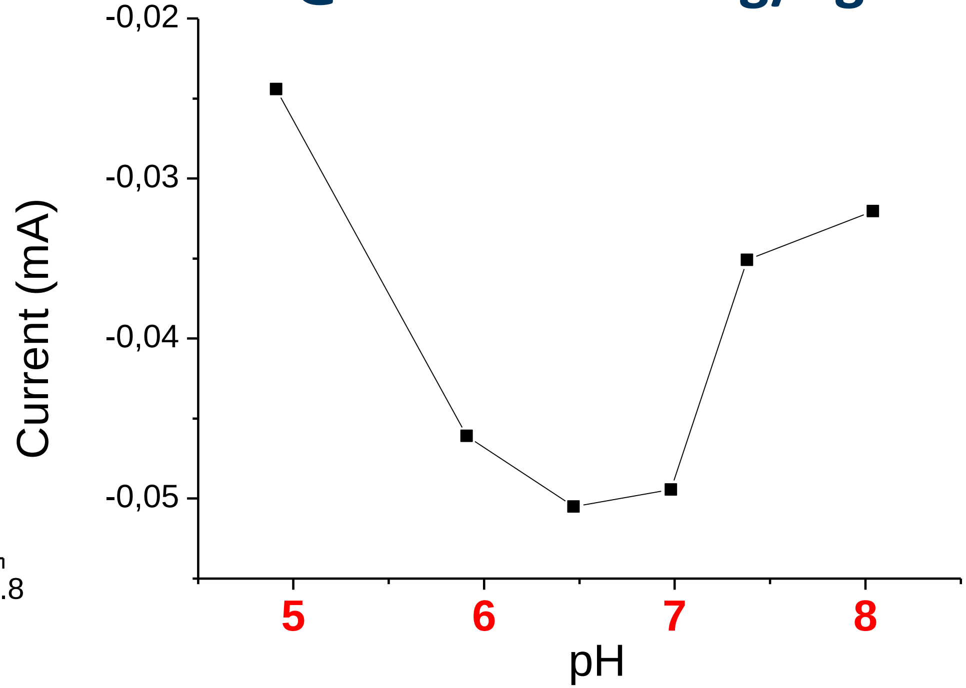


Bioelectrocatalytic current for H_2O_2 reduction at +600 mV

Optimum pH

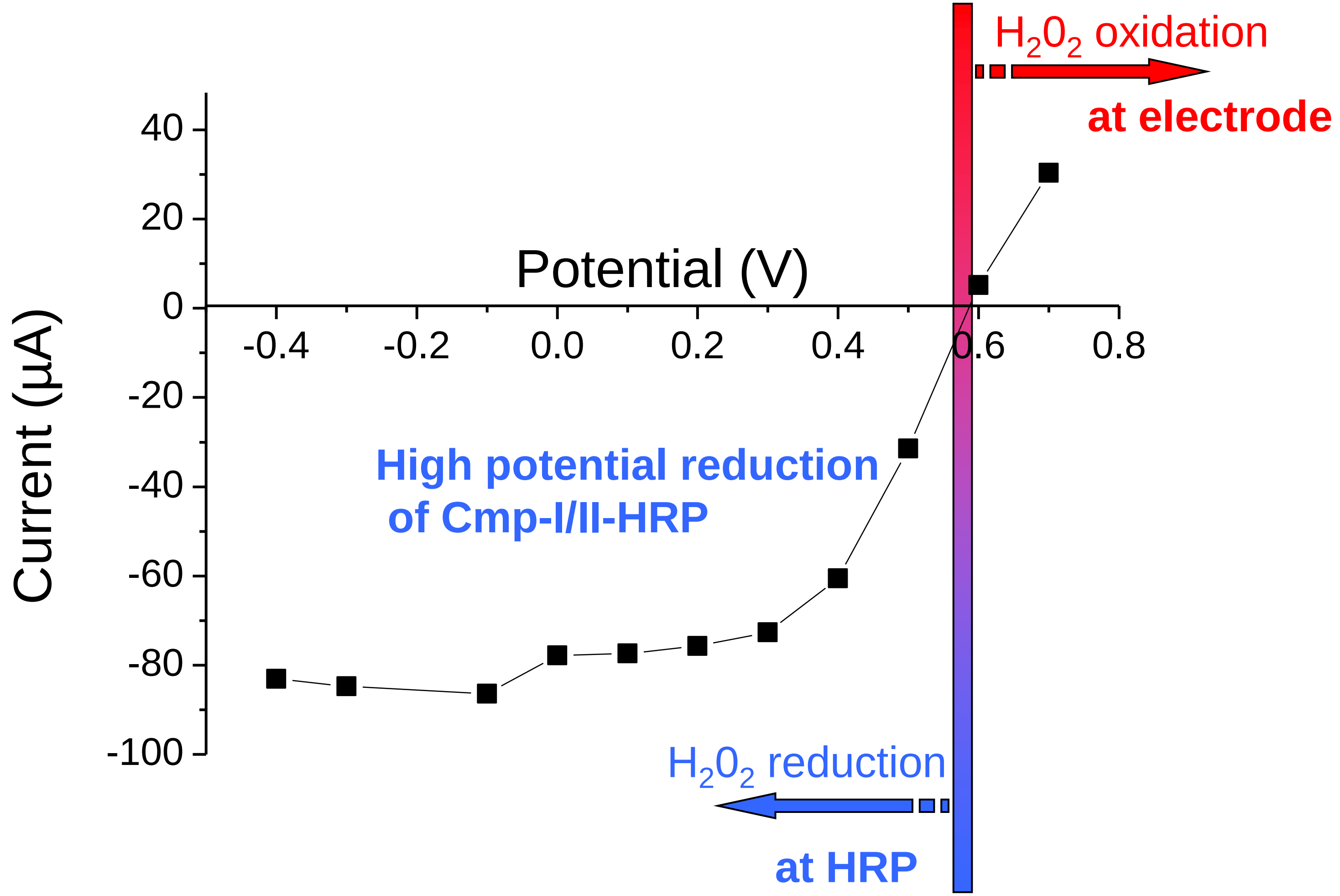
@ +400 mV vs. Ag/AgCl



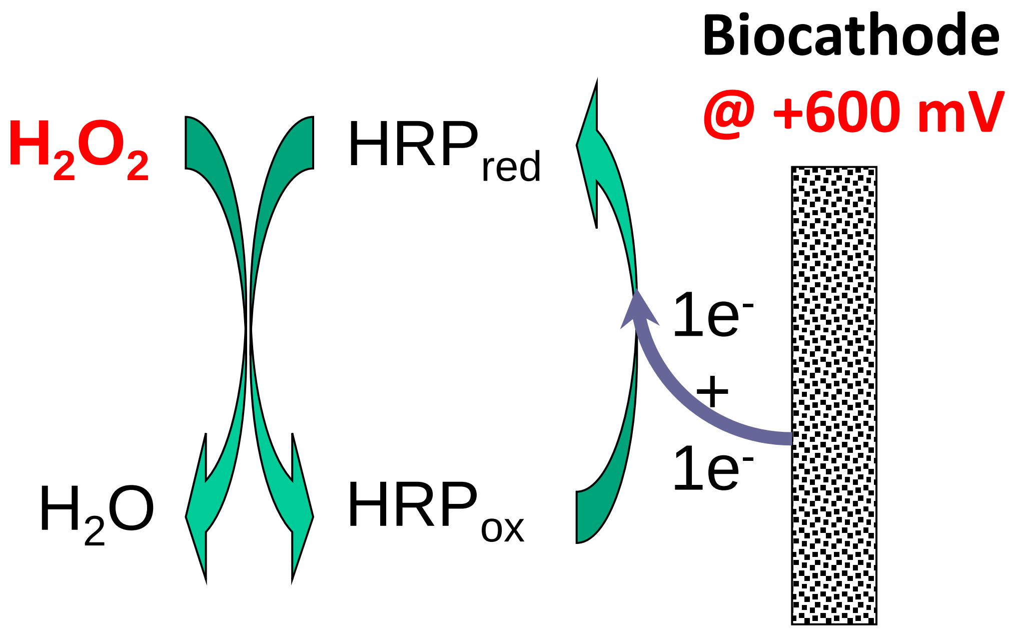


PHA - pyrene-hexanoic acid

Hydrodynamic voltammogram



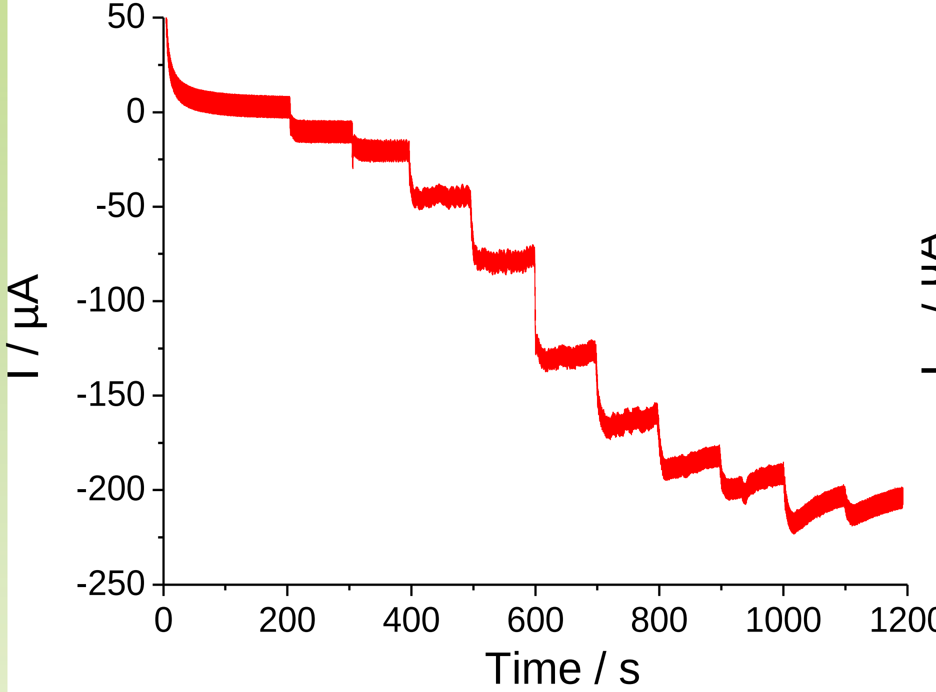
Scheme of H_2O_2 involvement



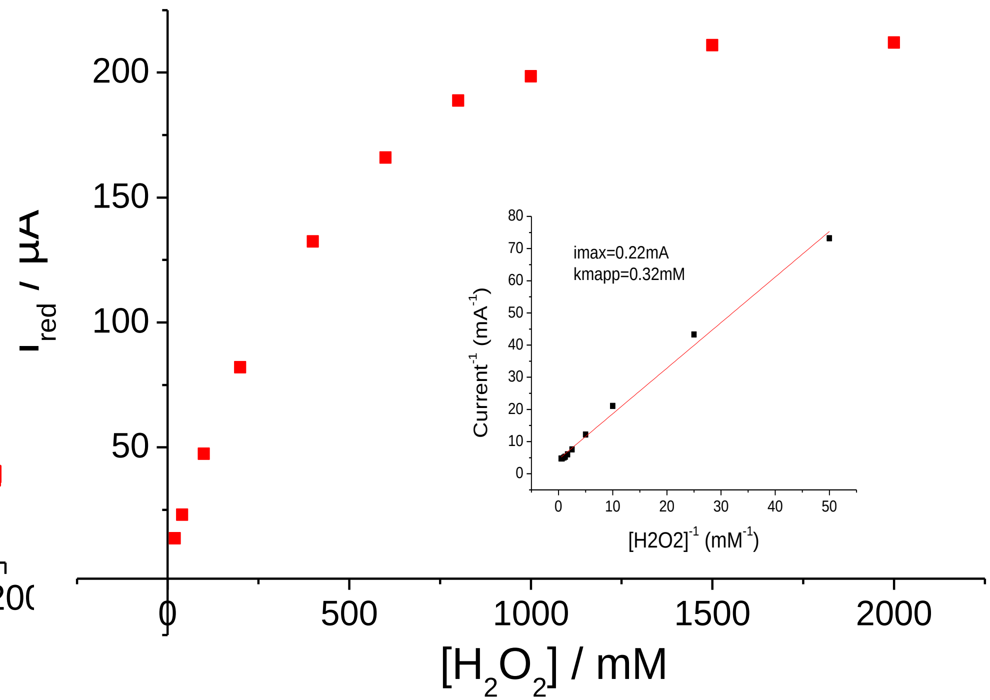
W. Jia, S. Schwamborn, C. Jin, W. Xia, M. Muhler, W. Schuhmann, L. Stoica *PCCP* **12** (2010) 10088.

H_2O_2 biosensor at +400 mV @ no O_2 involvement

I_{max}= **220 µA** (~ 1.5 mM H_2O_2)

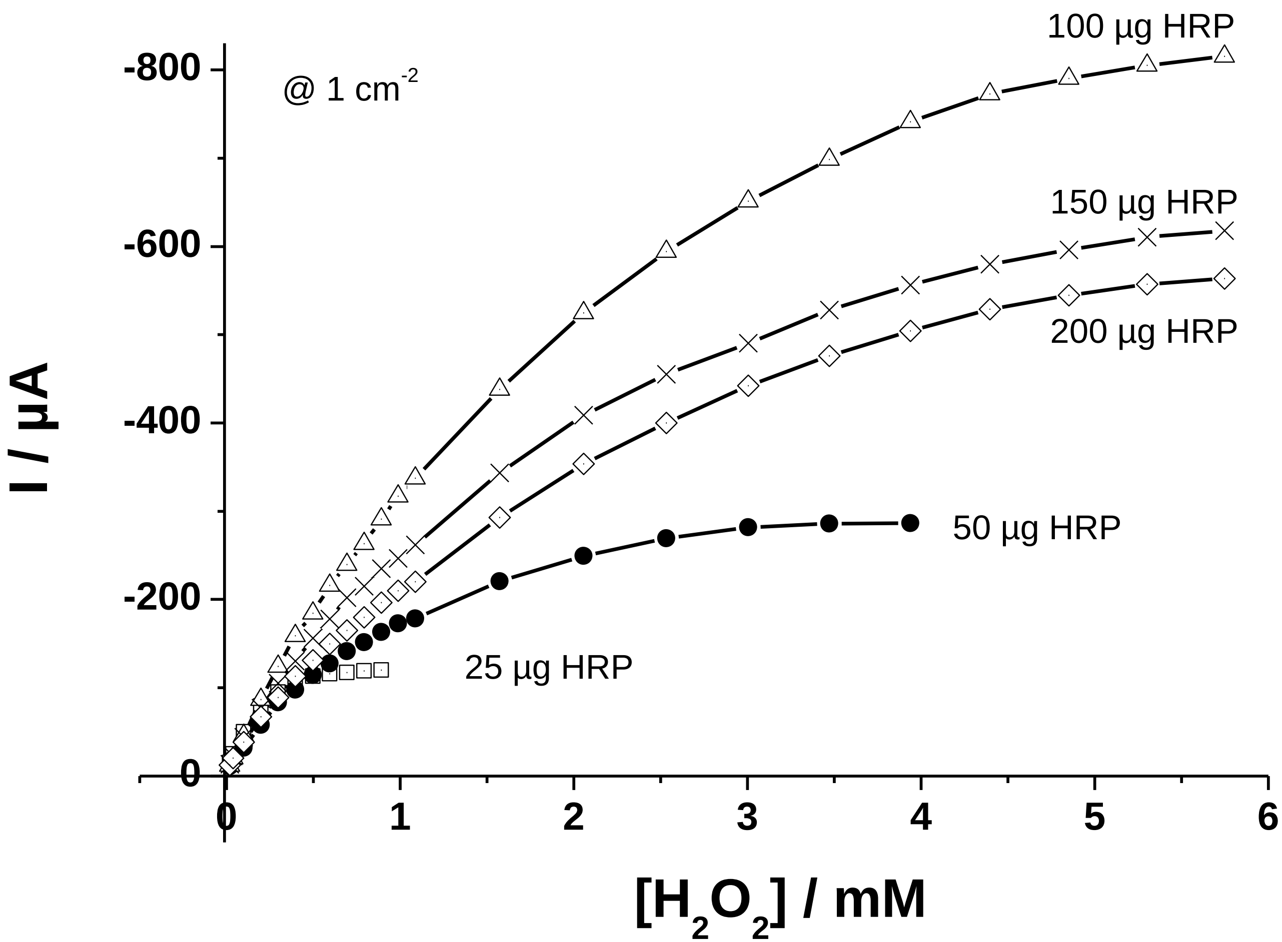


K_M= 320 µM H_2O_2



Amperometric responses of the **HRP/PHA-CNTs/CF/GR** biosensor were recorded by additions of H_2O_2 in N_2-saturated **PBS (pH 7.0) at +400 mV**

HRP loading



E_{appl}=+300 mV

Is „glucose based cathode“ a promising candidate?

Biocathodes based on...	***E_{onset}***	***pH_{opt}***	***Cl^- inhibition***	***e^- / O_2 yield***
Laccase	**+650**	**4**	**YES**	**4 e-**

$P_{out} = E \times I$ [E]; A; k_{cat}, n $E^{0'}$

Conclusions

3D-hierachical carbon nanostructures:

– present excellent characteristics for large active area and enhanced/"novel" bioelectrocatalysis of known redox enzymes;

Biocathode enzyme:

– Yes, indeed, high potential biocathode functioning on glucose/oxygen is feasible at *in-vivo* conditions (pH, Cl^-)

Acknowledgements go to...

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Thank you
for your attention!