CHARLES UNIVERSITY
CENTRE OF ADVANCED MATERIALS

CUCAM
Charles University Centre for Advanced Materials

Russell Morris

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Advanced Materials

- *mastering the design, research and development of new and improved materials will remain key for achieving the goals of the European Innovation Policy, in agreement with the European Strategy for a smart, sustainable and inclusive growth (EUROPE 2020).*
- *All major economies have initiatives in Advanced Materials*

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Our aims

- This proposal aims to develop a world-leading Centre of Excellence in Advanced Materials located at Charles University (CU) in Prague, covering the Design, Synthesis and Application.
  - Our focus will be in developing low dimensional compounds as the building blocks for the development of new materials
  - Hybrid materials

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The vision

- Is that creative chemistry is the wellspring from which the next generation of advances in materials technology design will flow.
  - Fundamental, inventive science is key
  - But the next generation of scientists will need to have one eye on how fundamental science can be translated

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Why Charles University

- The three Ps
  - Prague
    - the environment
  - People
    - The young talent in the centre is extremely important
  - Promise
    - The potential for top quality science is very much at the forefront of why this group of scientists make an exciting centre

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Successful Outcomes

- For a successful Centre the output of the work should be more than the sum of the individual researchers.
- An internationally recognised centre of scientific excellence
- A Centre that has impact!

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Impact

- Impact through science
  - Providing an environment where the best possible science is
- Impact through inspiration
  - Improving the human capital resource in Czech Republic through inspiring younger researchers
- Impact through advocacy
  - Making the Centre a trusted partner for decision makers in Government and industry

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Scientific Objectives

- The key scientific advances proposed for the Centre are
  - The development of new chemistry concepts that will allow step changes in exploitation of the outstanding properties of advanced materials in a way that has not been possible previously.
  - The development of generalised synthetic strategies to target novel properties, and subsequent demonstration of these properties.
  - The use of world-leading characterisation and computational techniques to connect novel chemistry to new properties through transformative synthetic chemistry, structural characterisation and computational prediction and simulation.

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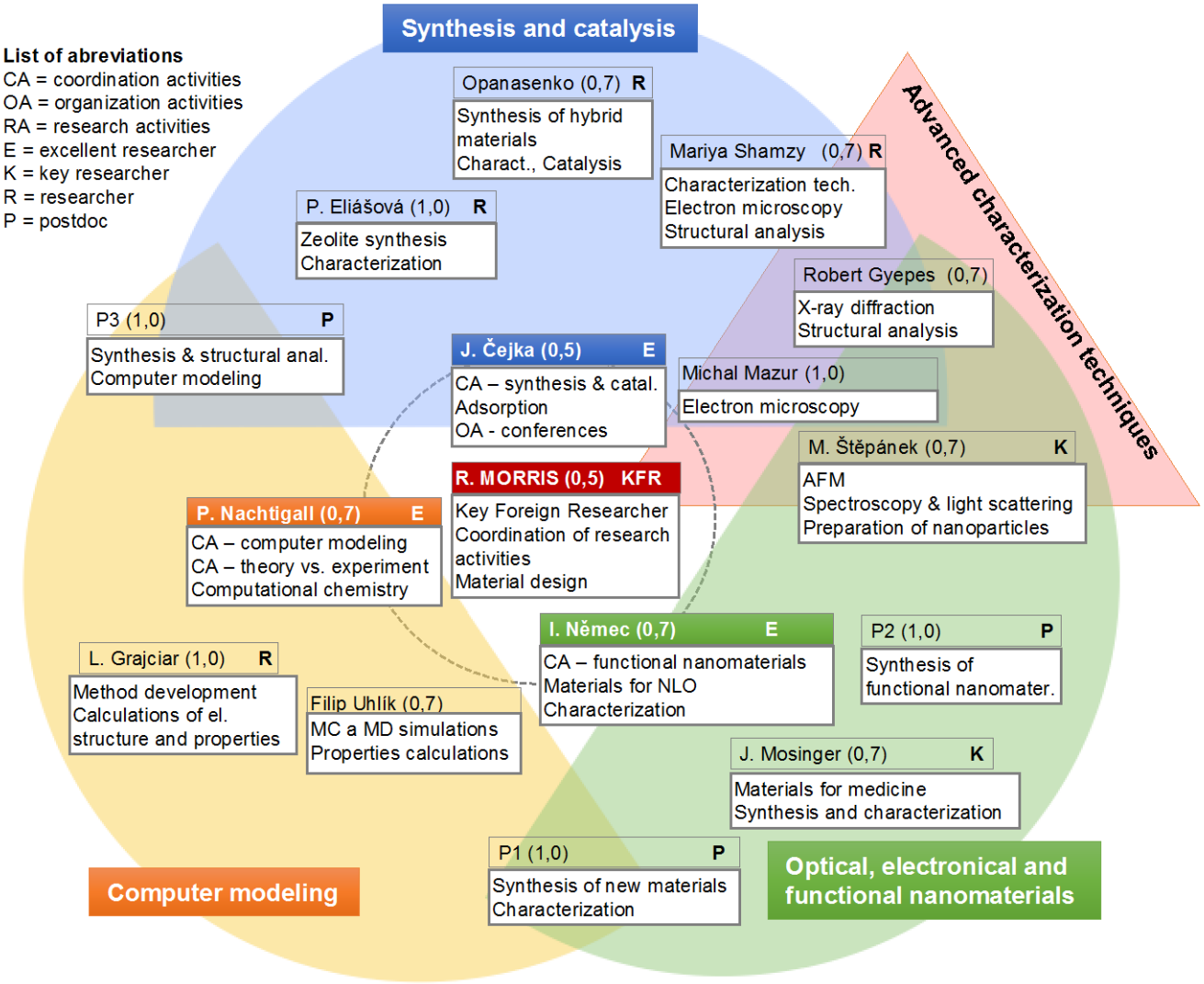
List of abreviations
CA = coordination activities
OA = organization activities
RA = research activities
E = excellent researcher
K = key researcher
R = researcher
P = postdoc



Color scheme:

Synthesis and catalysis	Computer modeling	Optical, electronical and functional nanomaterials	Advanced characterization techniques

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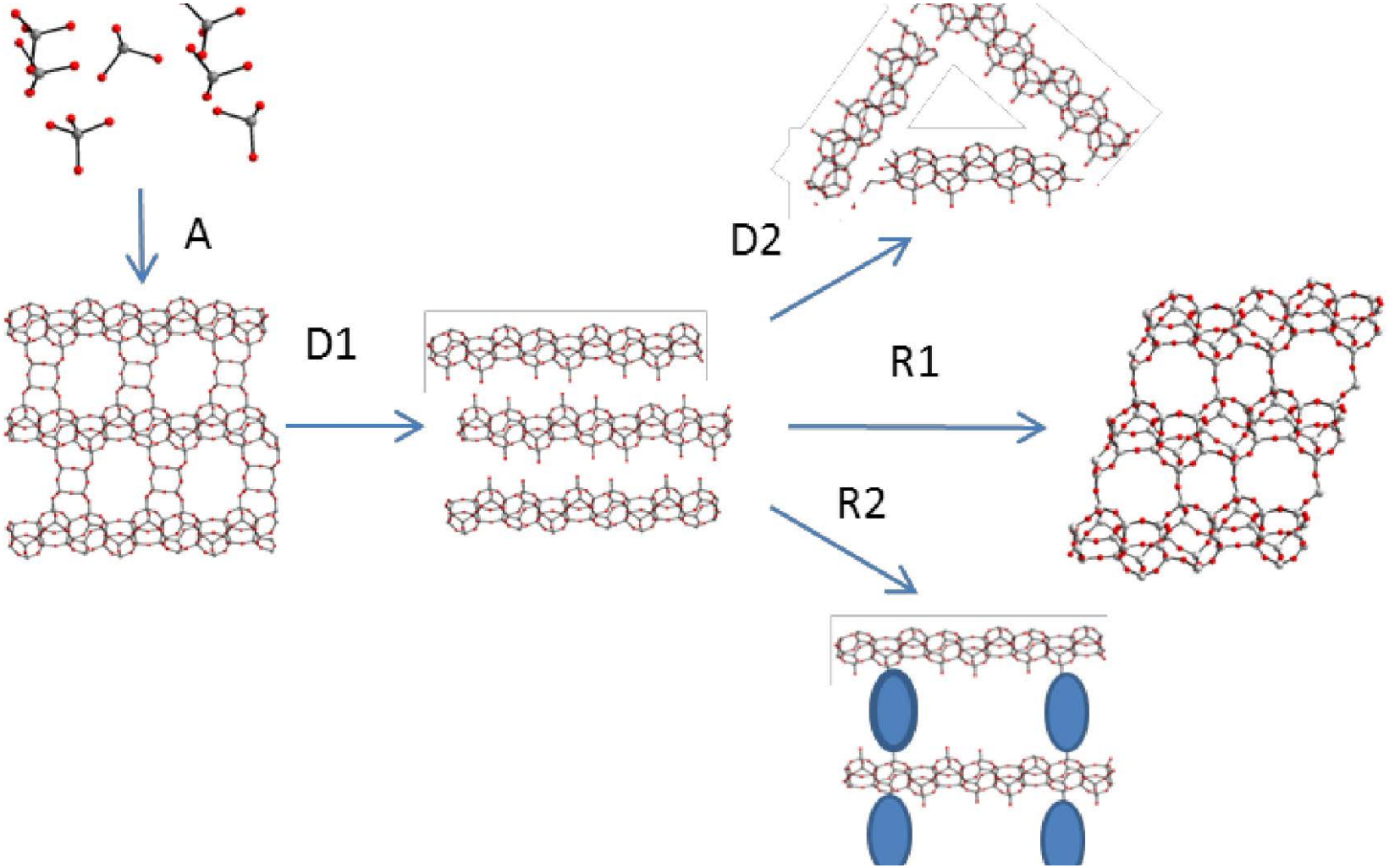
Synthesis & Catalysis



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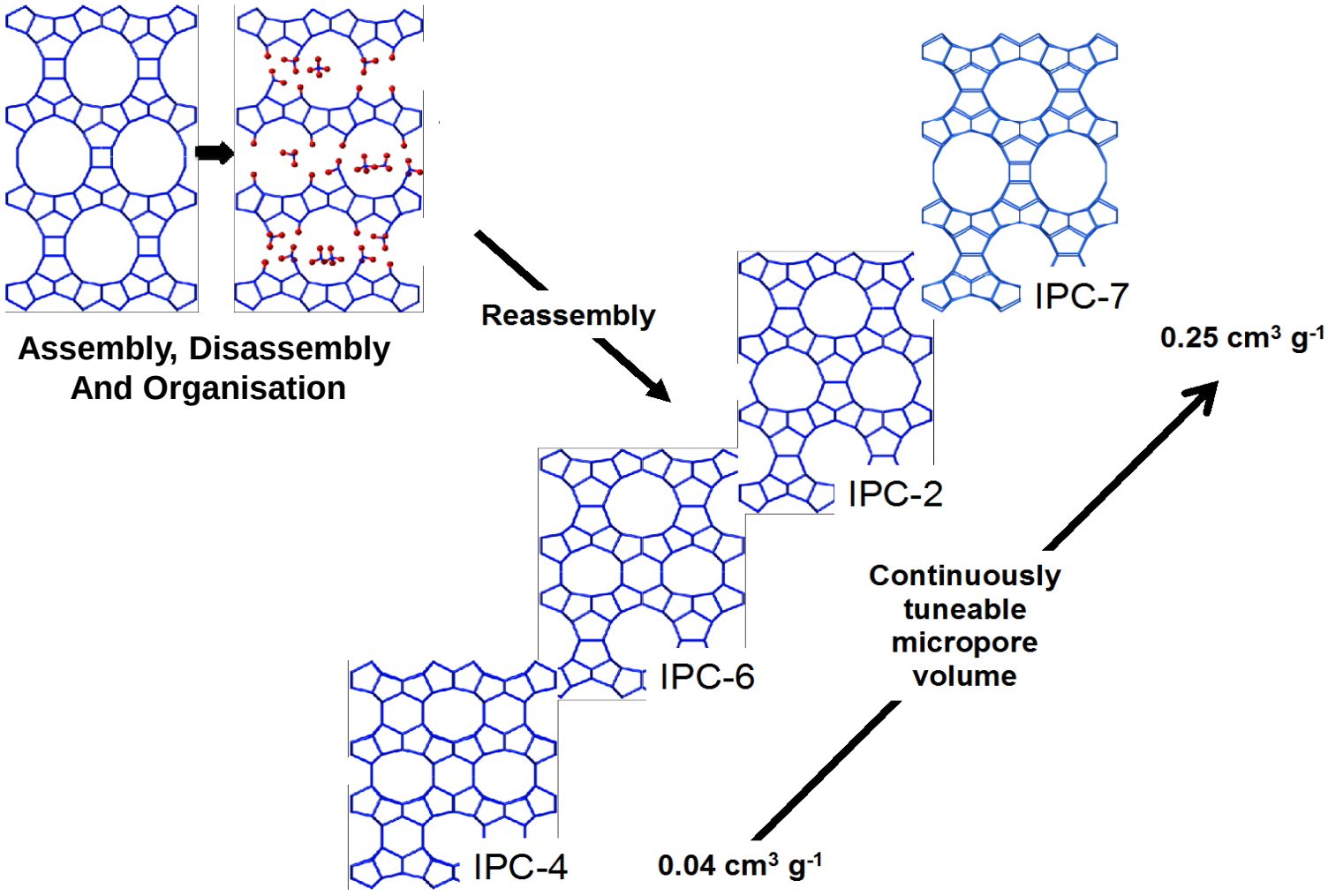
The ADOR process



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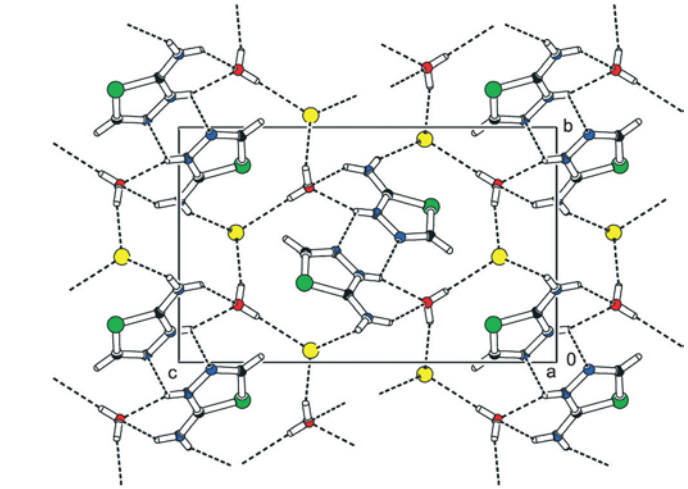
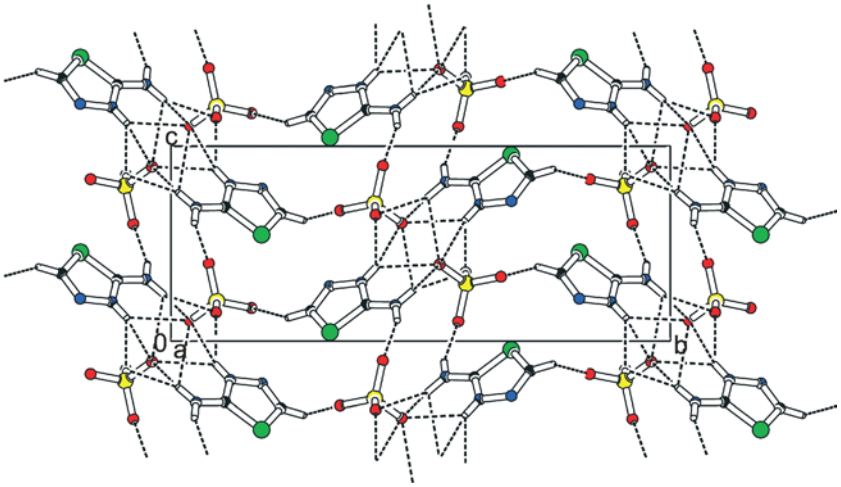
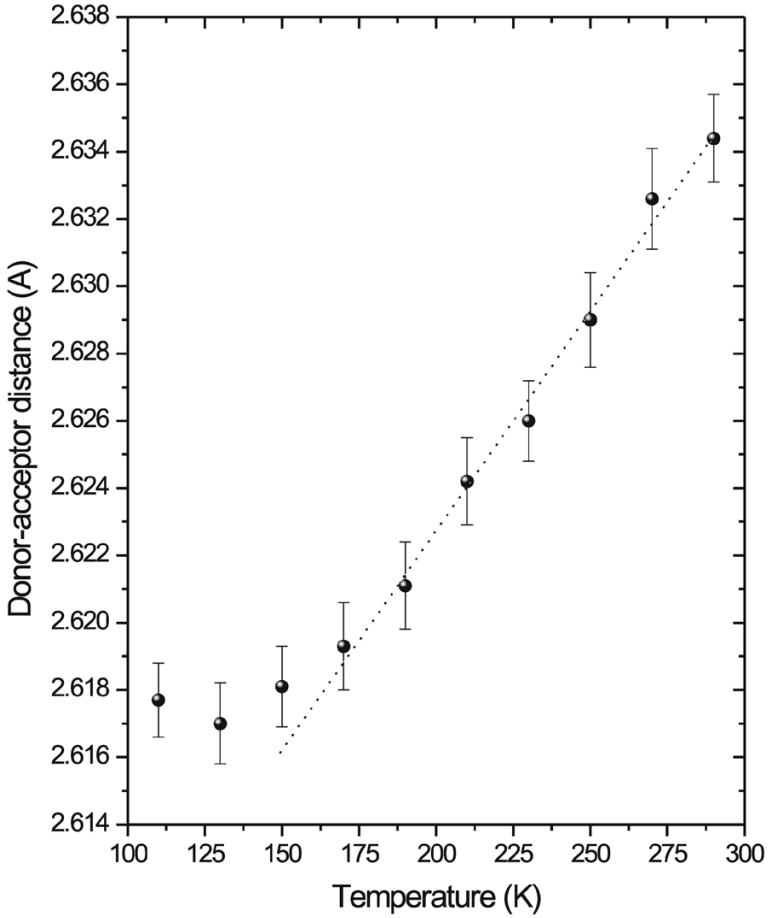
Crystal Engineering for NLO







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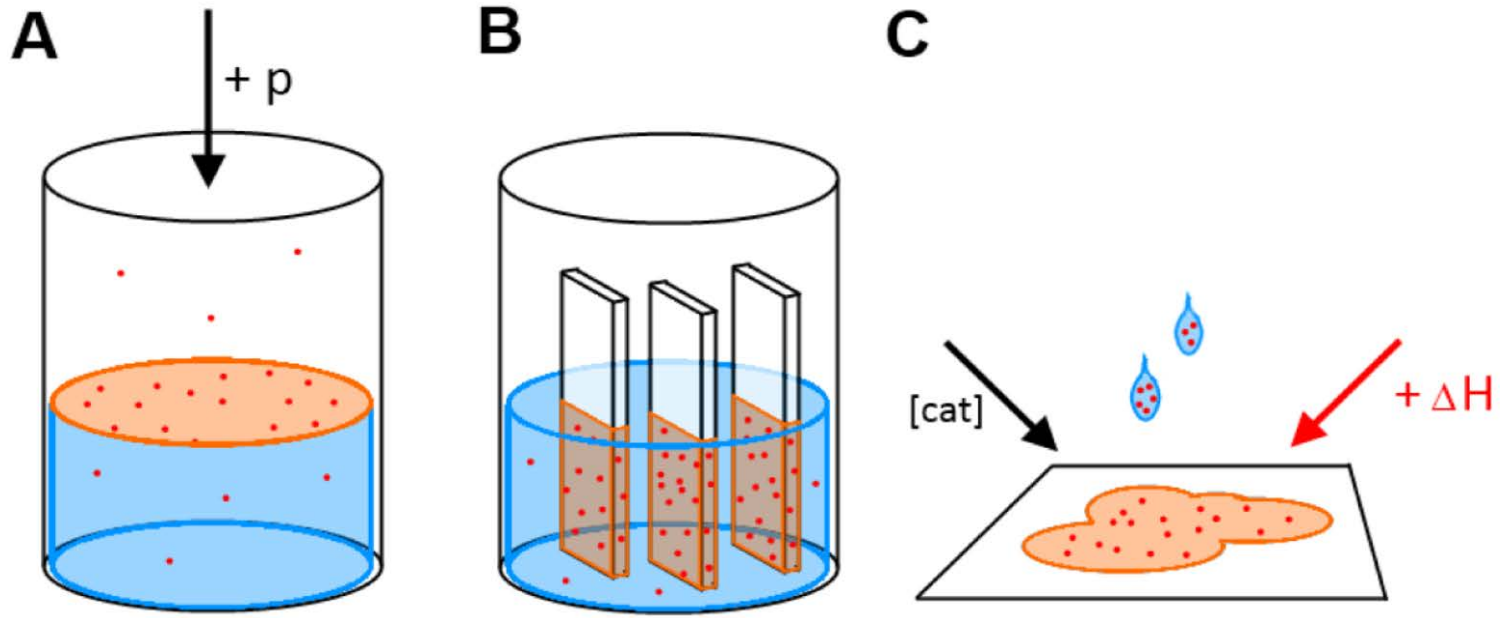
Graphene-based heterostructrues

Extending the graphene family to include triazine –based carbon nitride materials



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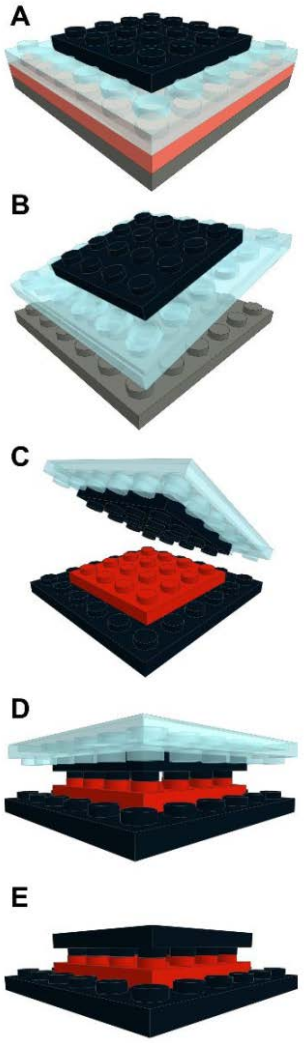
Processing of 2D materials



- Layer by layer processing of hybrid heterostructures

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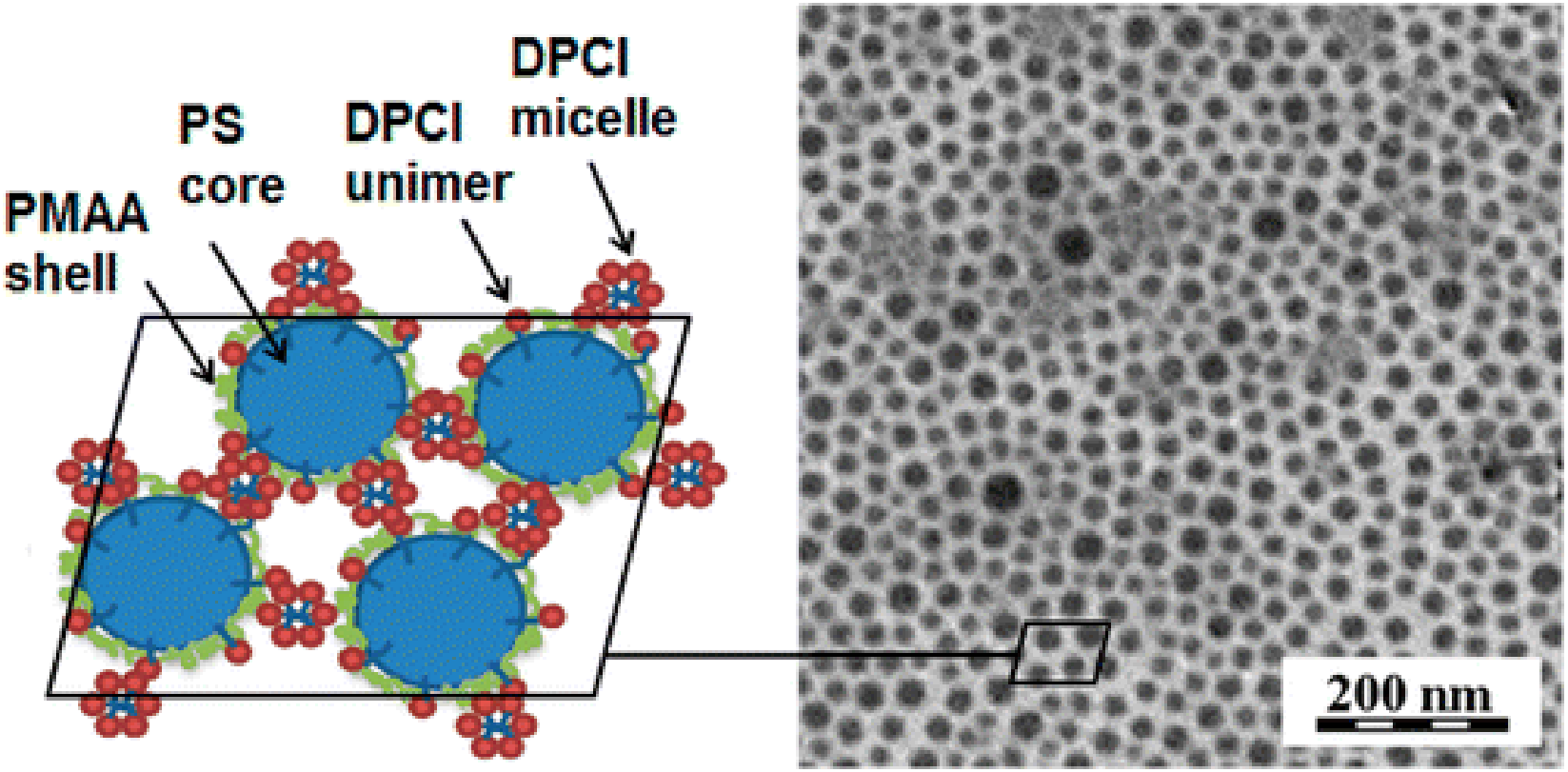
‘Hybrid’ nanoparticles



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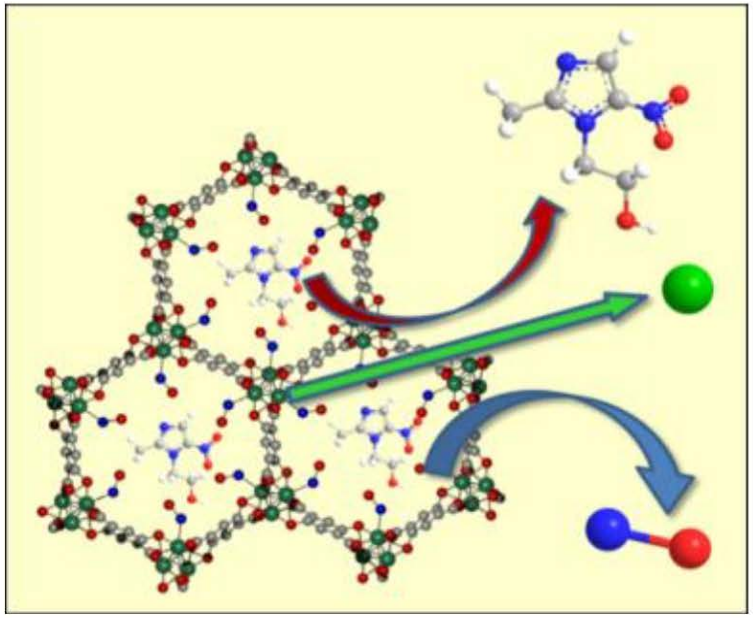
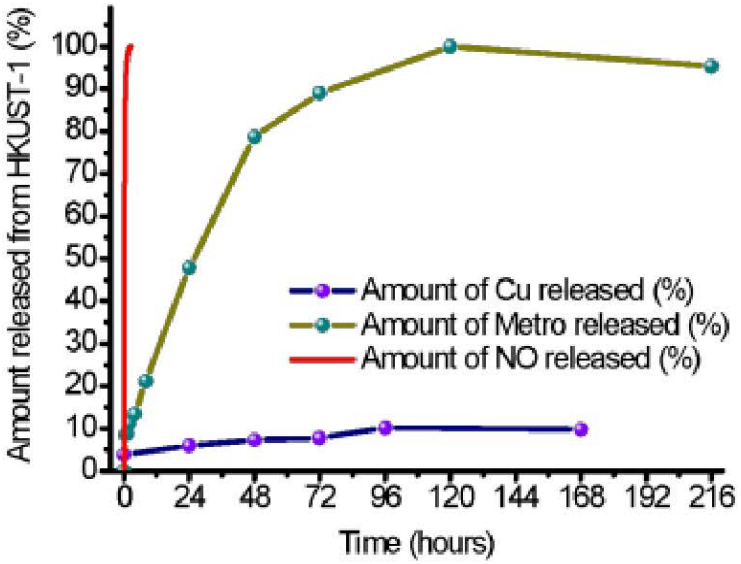
Multifunctional therapeutic materials





- Multirate delivery of multiple therapeutic agents for combination therapies

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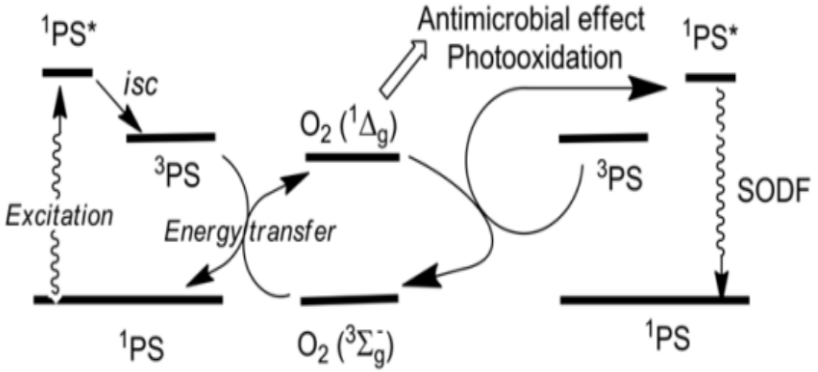
Singlet Oxygen

A



B

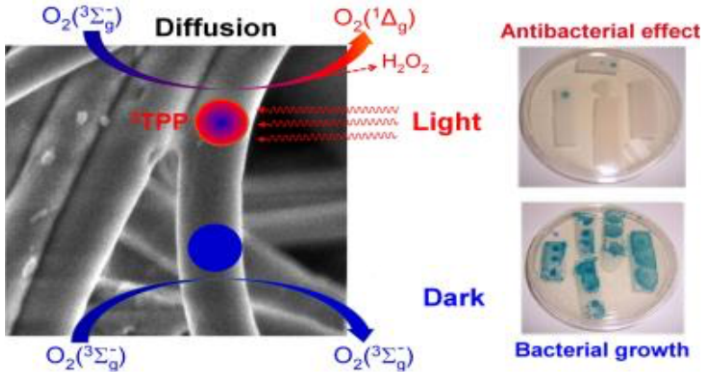


Figure 6. (A) Simplified energetic scheme of the photosensitized generation of $O_2(^1\Delta_g)$ and singlet oxygen sensitized delayed fluorescence (SODF): isc designates intersystem crossing, $^1PS^*$ and ^3PS are excited singlet and triplet states of photosensitizers, respectively. **(B)** The principle of antibacterial effect of nanofiber materials with encapsulated tetraphenylporphyrin (TPP) photosensitizer. Singlet oxygen is generated only at visible light and has an antibacterial effect.

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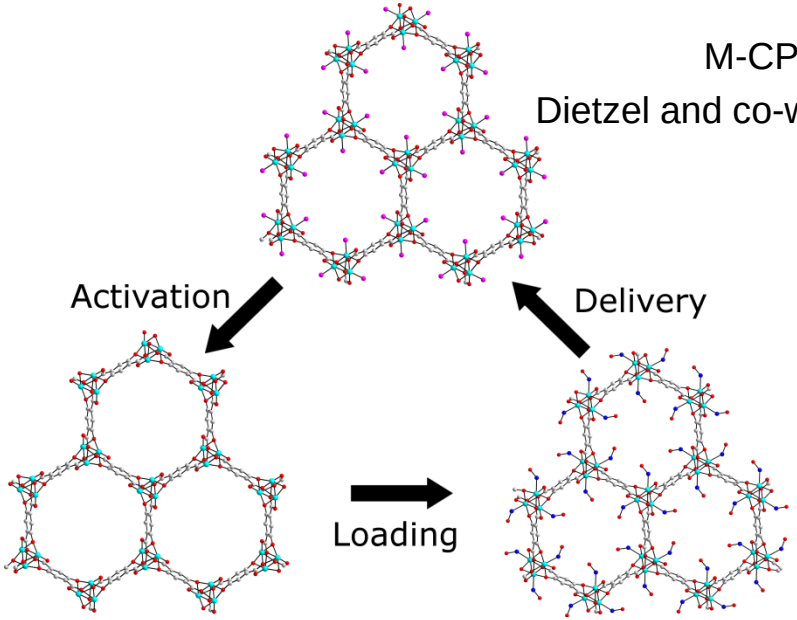
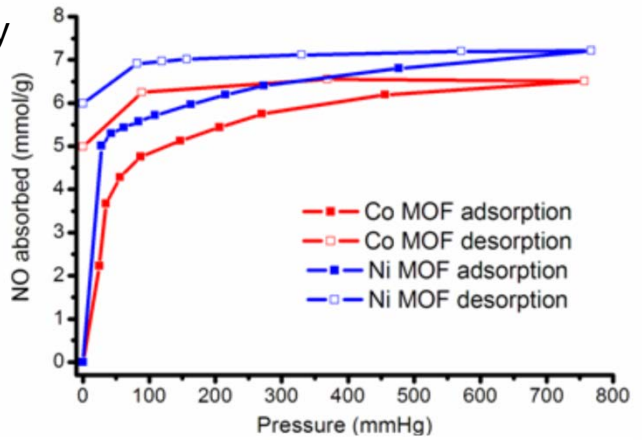
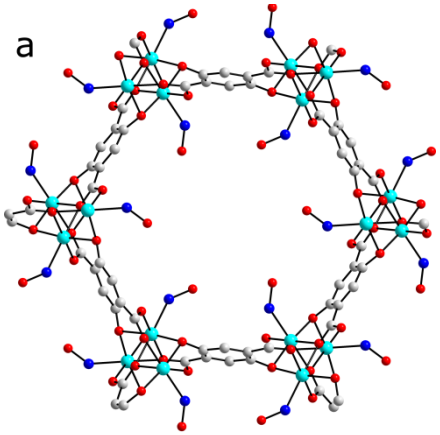
NO – delivery materials

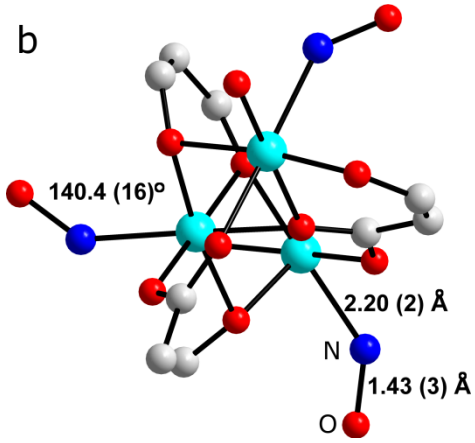
M-CPO-27

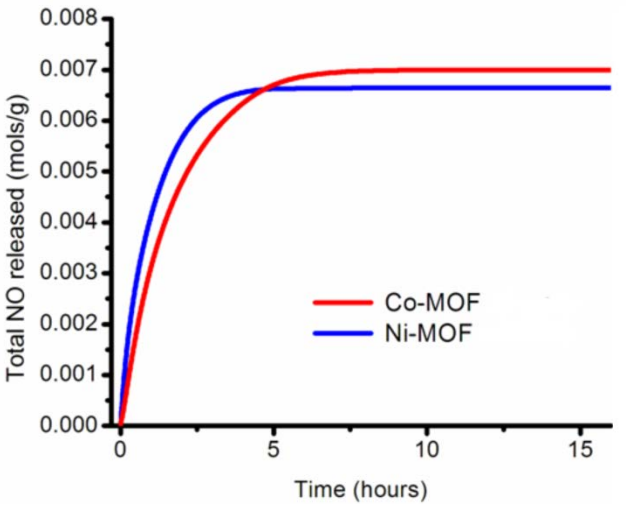
Dietzel and co-workers Norway











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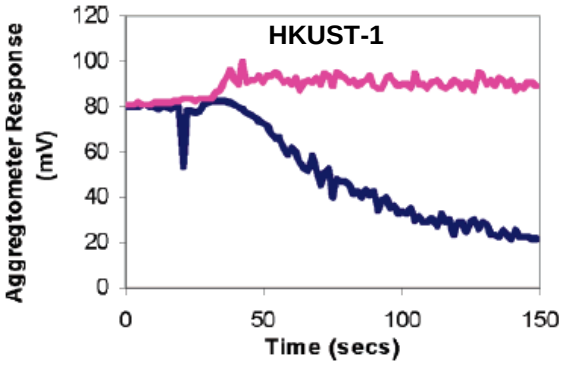
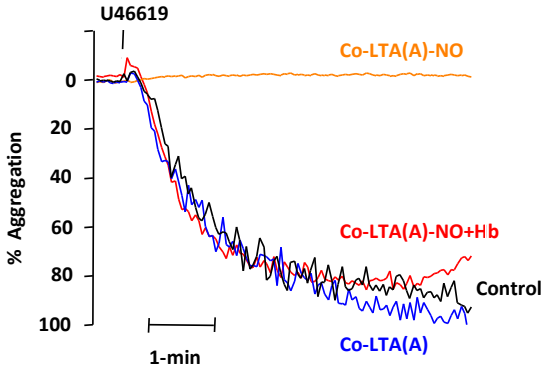
Biology: Anti-thrombosis Materials

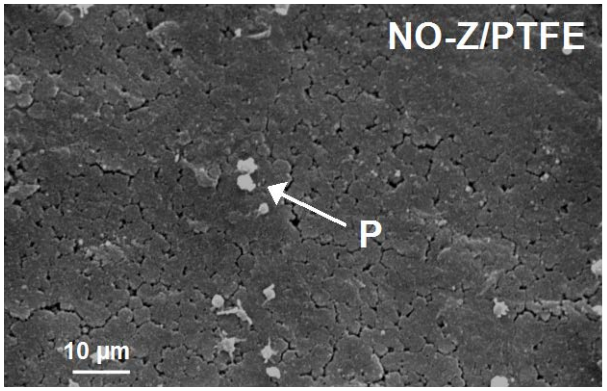
- Platelet aggregation
  - Both zeolites and MOFs inhibit platelet aggregation

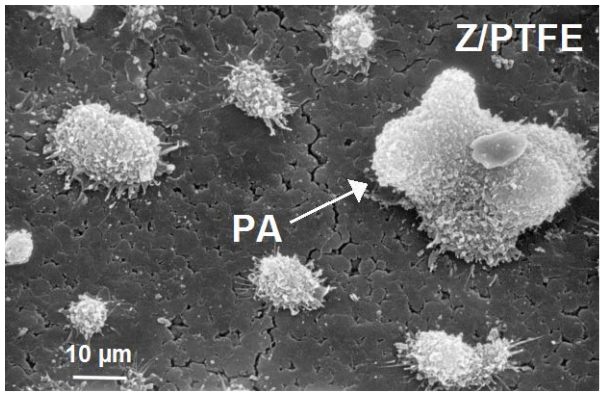




Paul Wheatley

- Platelet Adhesion





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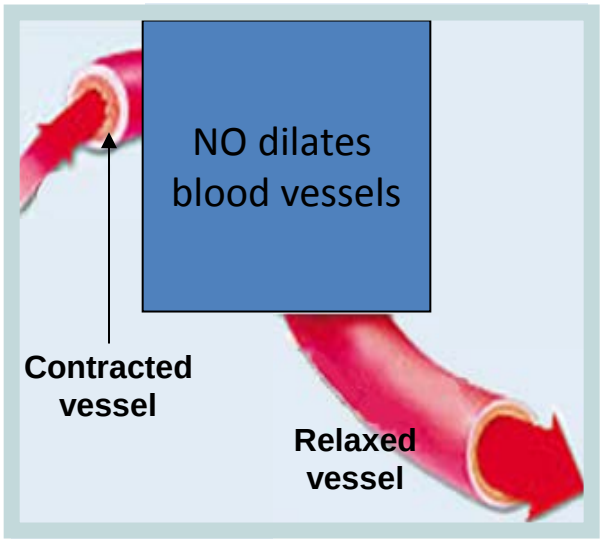
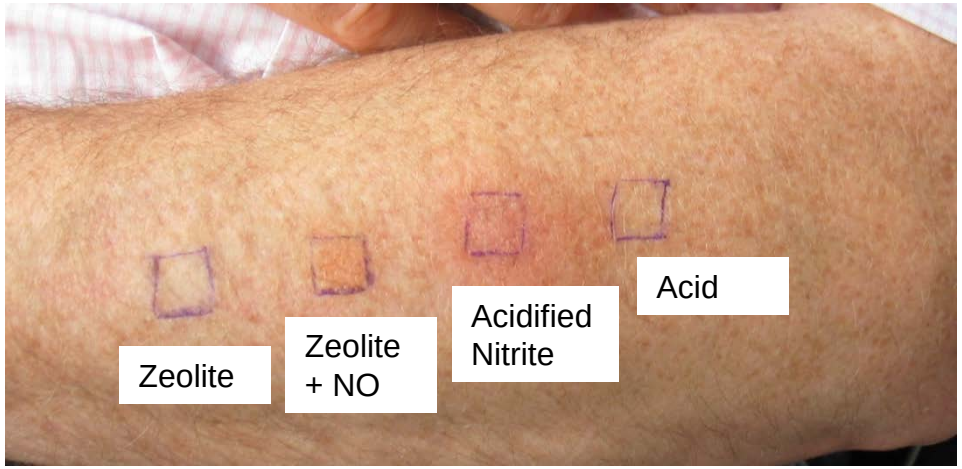
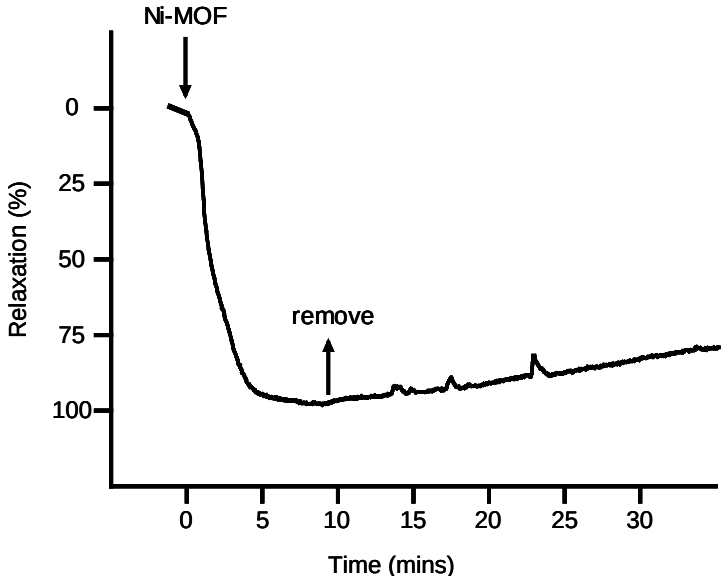
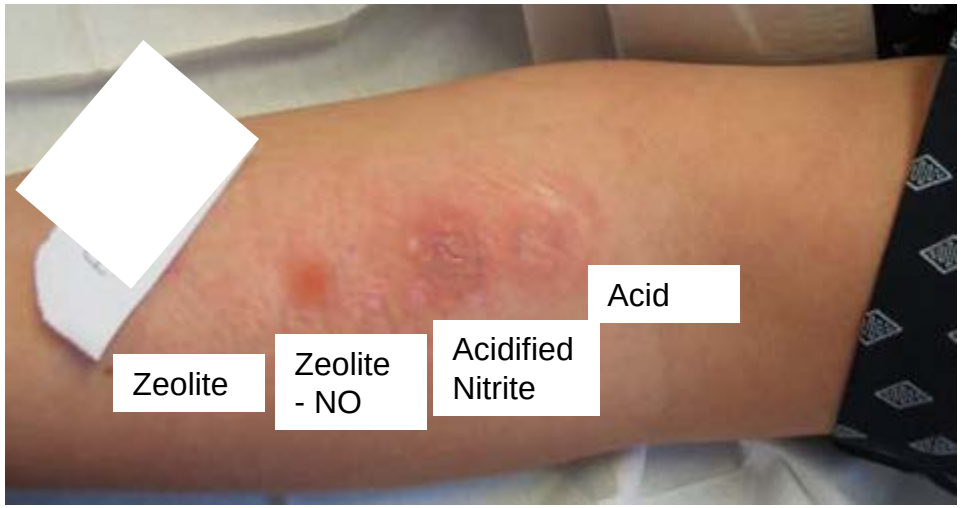
Dermatology Studies









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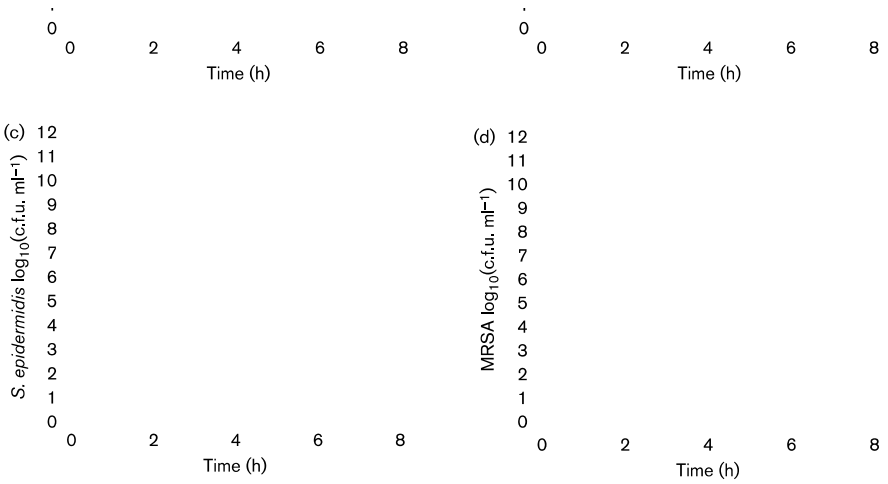
Anti-Bacterial NO zeolites



(a) E. coli, (b) A. baumannii, (c) S. epidermidis, (d) MRSA

Neidrauer et al Journal of Medical Microbiology (2014), 63, 203–209

	(NO–zeolite versus initial)	(NO–zeolite versus untreated)
E. coli	5.9	8.4
A. baumannii	6.1	8.6
S. epidermidis	5.7	5.1
MRSA	2.9	6.0
C. albicans	3.0	3.1

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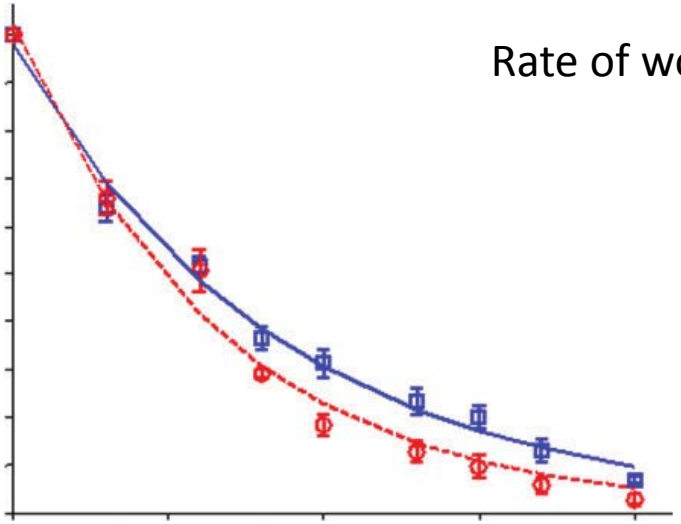
Wound Healing study



Rate of wound closure ~30% faster

Neidrauer et al Journal of Medical Microbiology (2014), 63, 203–209

Zeomedix

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Facilities

- Computer modelling
  - The importance of computers in designing new experimental work cannot be overstated
- Characterisation
  - XRD
  - TEM
  - Adsorption
  - Spectroscopy
  - Facilities for optical and electronic material charactersation