Royal Institute of Technology

Surface Engineered Nanofibers Composites for water Treatment

Research Activities Within EULA-NETCERMAT Project

Abdusalam Uheida

Functional Materials Division

KTH - Royal Institute of Technology, Sweden

Criciuma-Brazil, November 2013

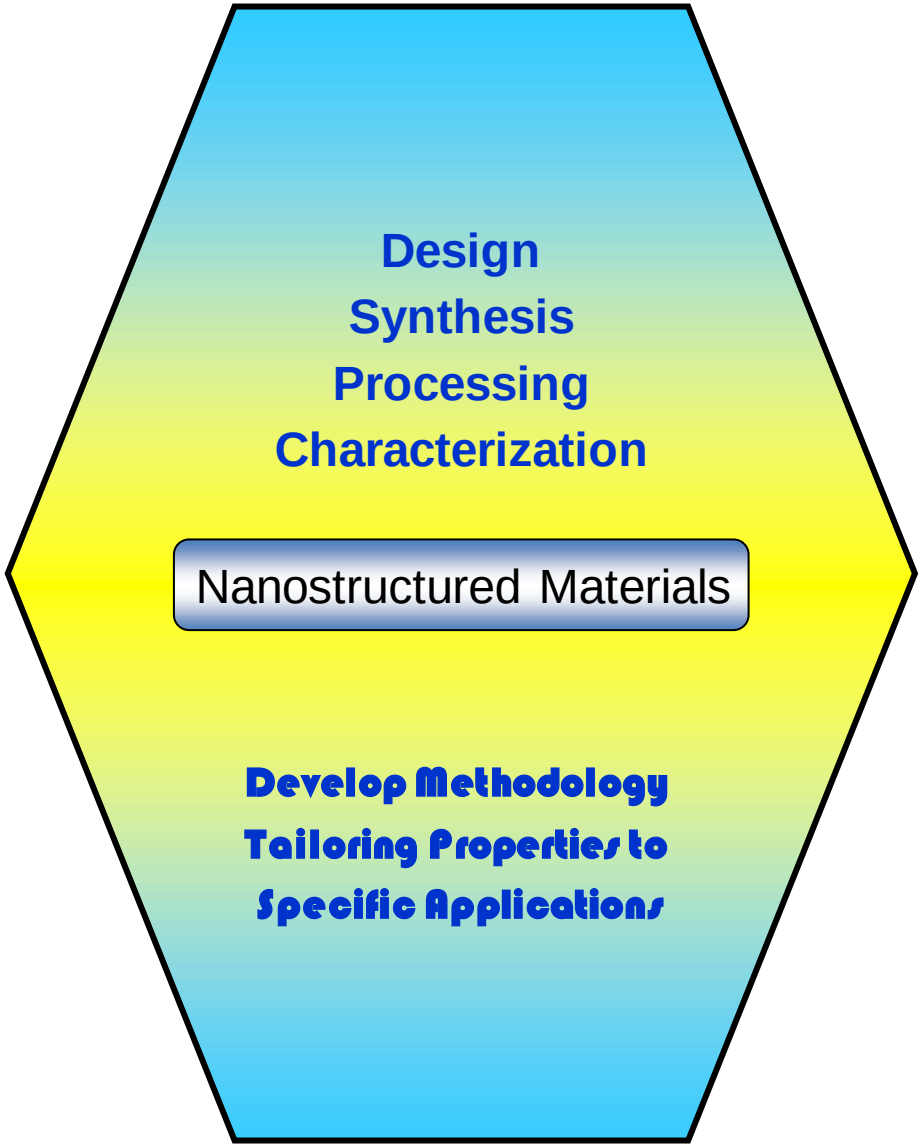
KTH Involvement in WPs

WP1 **SYNTHESIS AND CHARACTERIZATION OF ADVANCED CERAMICS**

Task 1.1.5 **Design of nanostructure materials (nanoceramics) and conducting comprehensive characterization of the fabricated nanomaterials.**

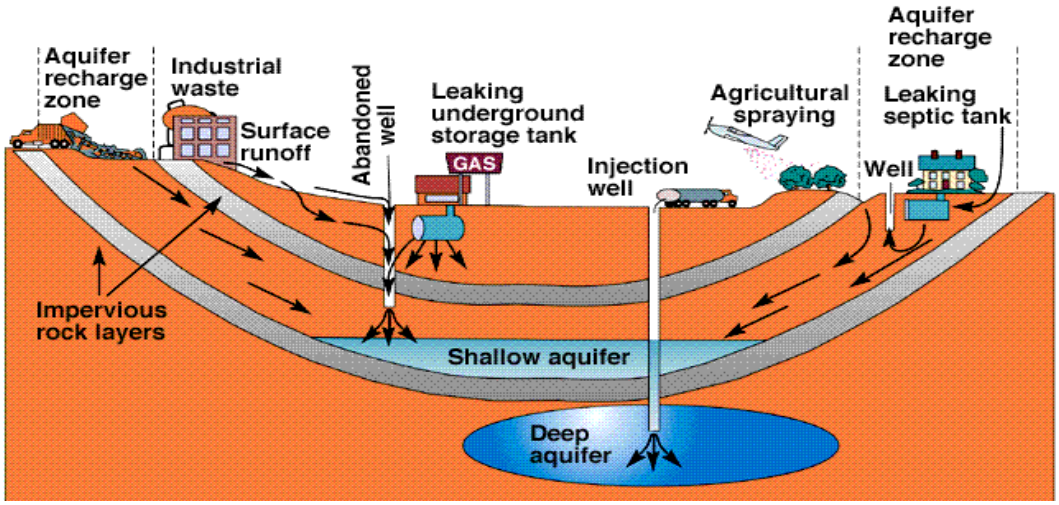
Task 1.1.6 **Exploit the applications of the fabricated Nanoceramics material in environment clean-up (water remediation).**

Nano-Environment Group at FNM



Environmental Clean-up

Potential Applications



Contaminated Soil Clean-up

Water treatment

- Industrial effluents treatment
- Drinking water purifications

Proposed Technology Outputs

- Clean-up waste streams and produce environmentally friendly effluents (e.g., no generation of secondary waste).
- Recovery of toxic components.
- Conversion of the separated waste to products that can be reused which can generate income for the industry.

Targeted Pollutants

Inorganic contaminates

Co : contaminated coolant water system in the nuclear power plants
As: underground water contamination
Cr: tanning and lather industries
Pb, Cu, Zn: contaminated mining sites

Organic contaminates

Pesticides: Agriculture industry
Organic dyes- Indigo Carmine: Textile industry
Pharmaceutical drug: Sewage Treatment Plants
(Antitumor antibiotics , Non-steroidal anti-inflammatory drugs, Antidepressant)

Targeted Pollutants

Recovery of High Valuable Metals

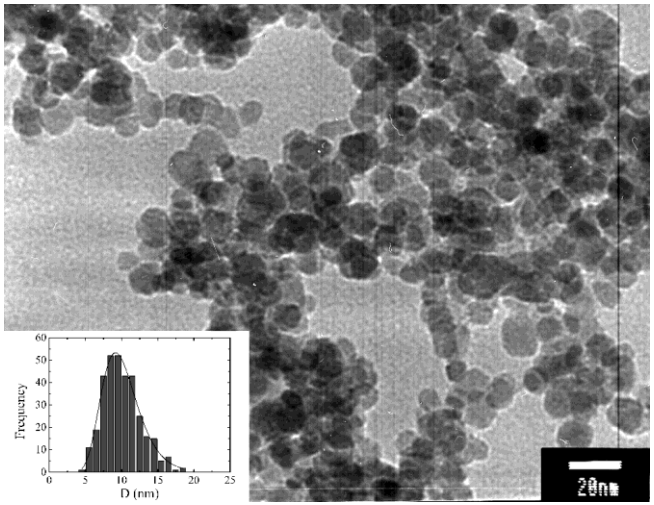
Rear Earths Elements-REE: Nd (magnetics), Gd (MRI contrast agent), Eu (electronics)

Platinum Group Metals (PGM): Car catalyst-Pd, Pt, Rh

Nanomaterials Tested

Nano-Adsorbents

Non-Selective adsorption



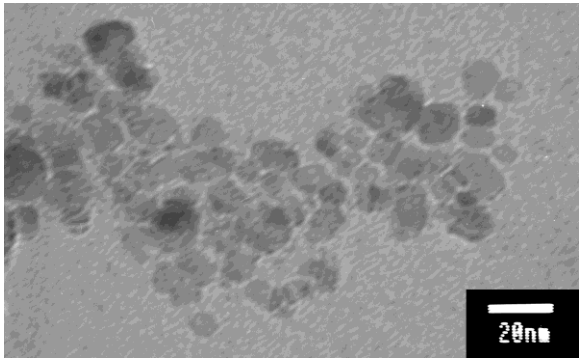
SPION

Fe_3O_4 , γ-Fe_2O_3

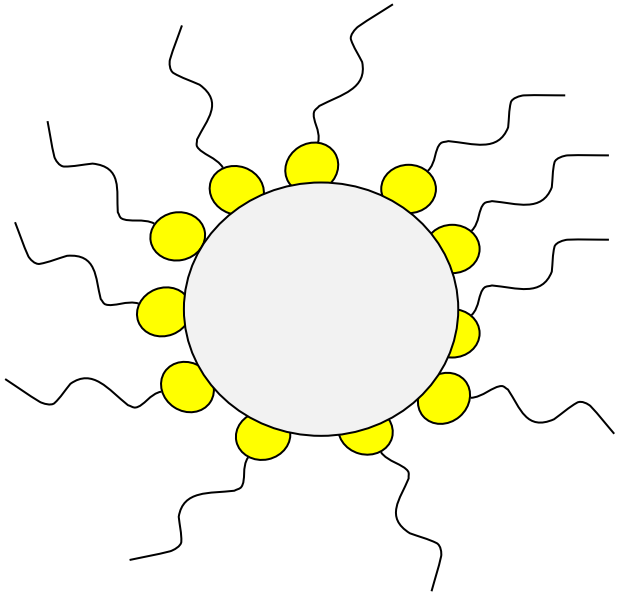
Nanomaterials Tested

Nano-Adsorbents

Selective Adsorption



TEM image

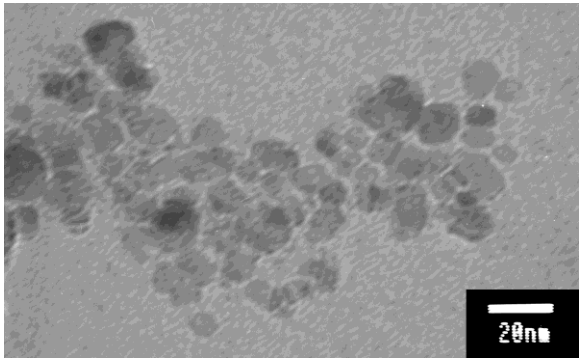


Surface modified SPION

Nanomaterials Tested

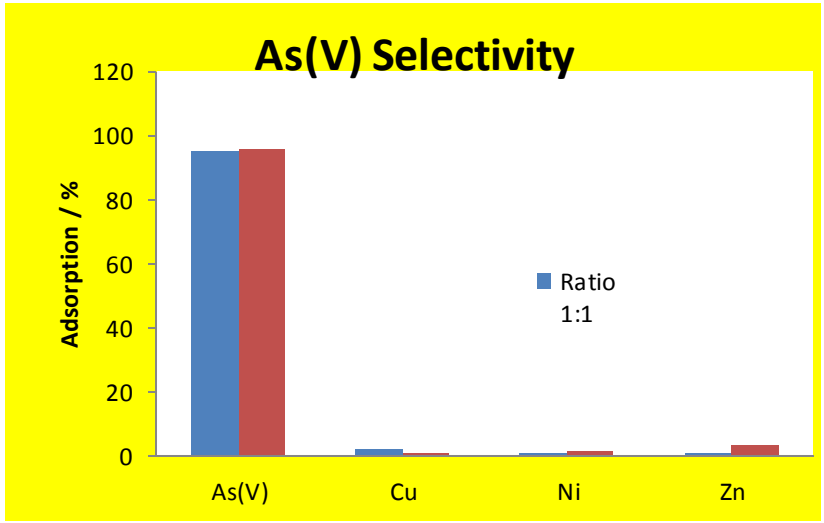
Nano-Adsorbents

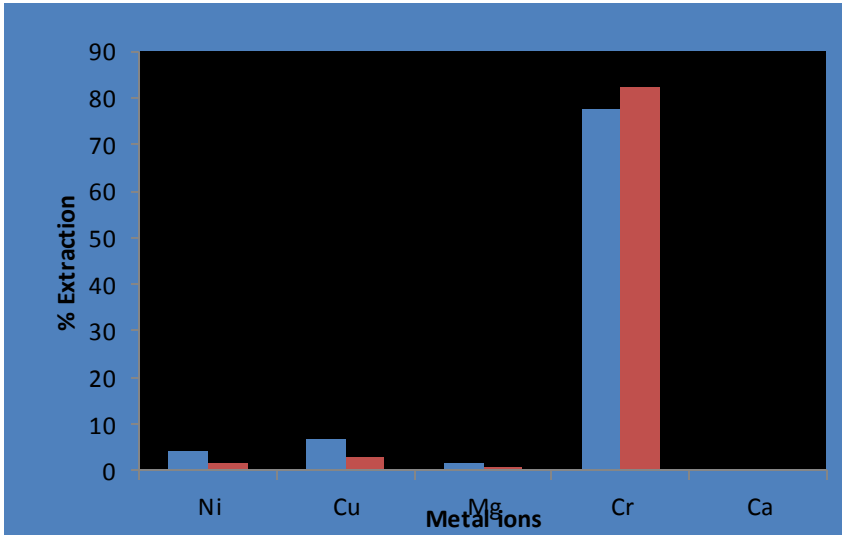
Selective Adsorption



TEM image

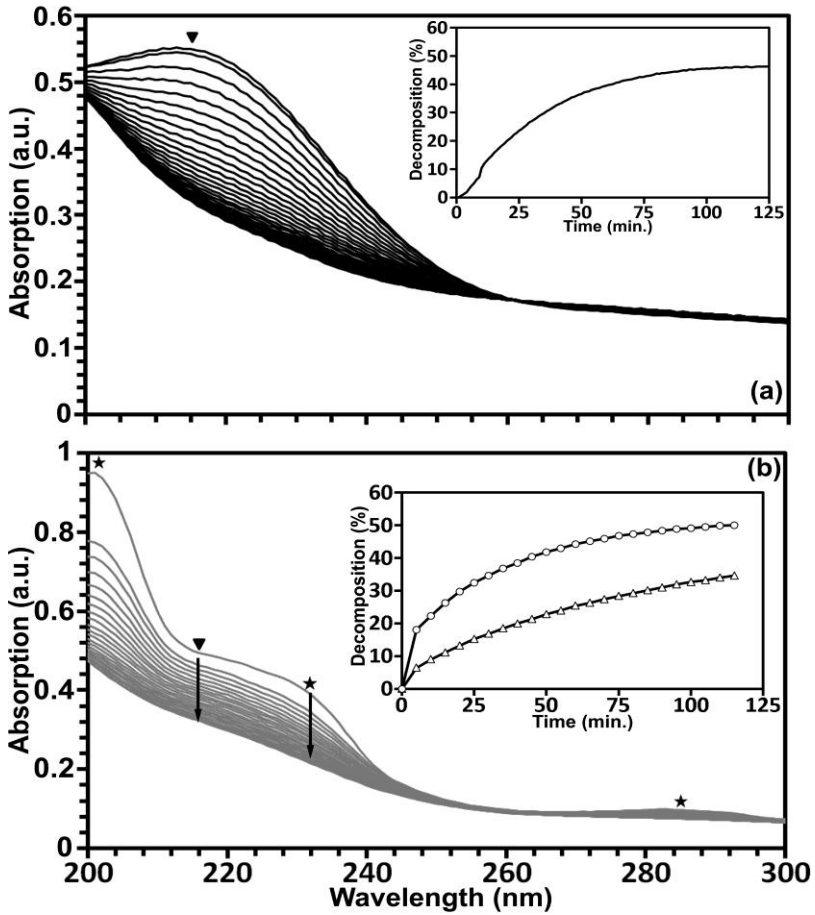
Surface modified SPION

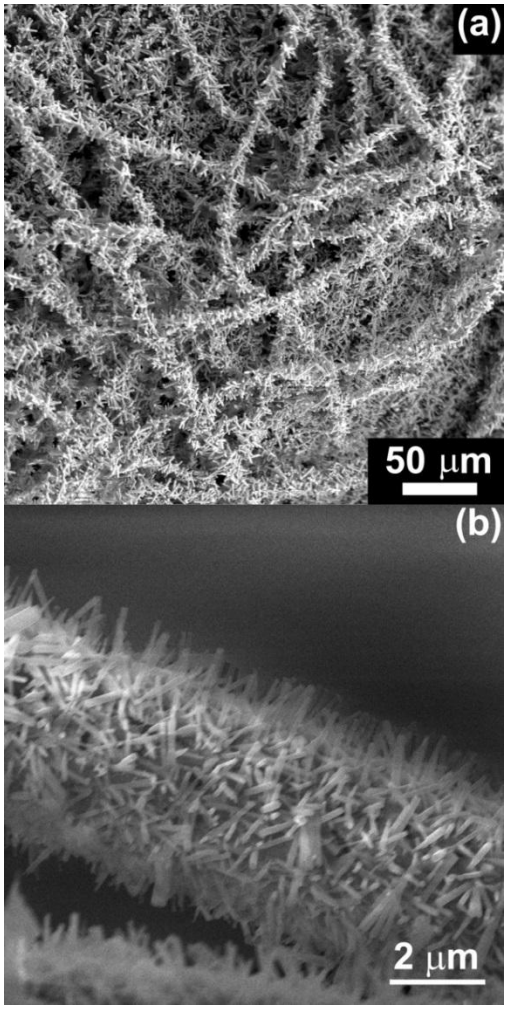




Nanomaterials Tested

Photo catalytic

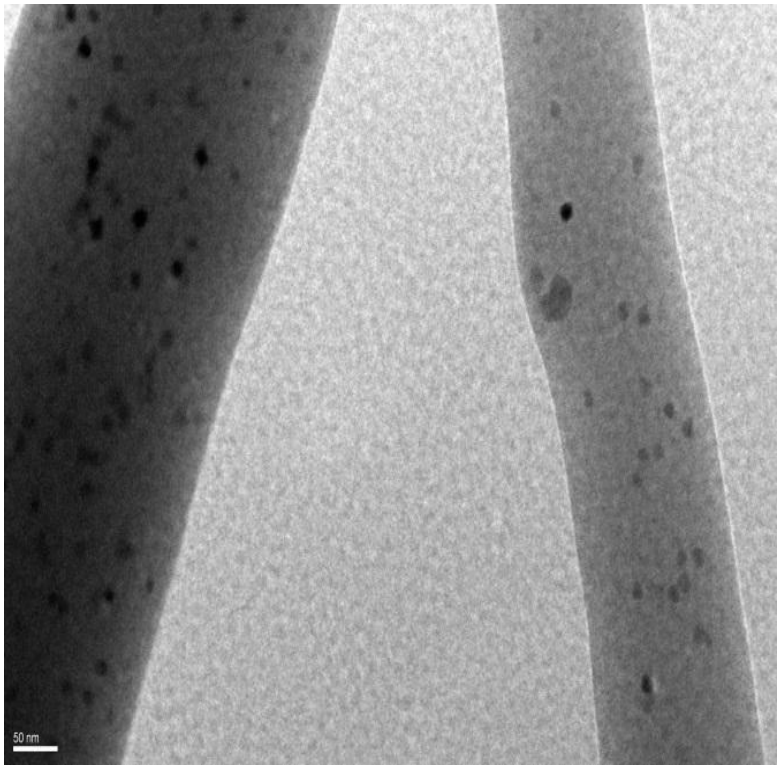




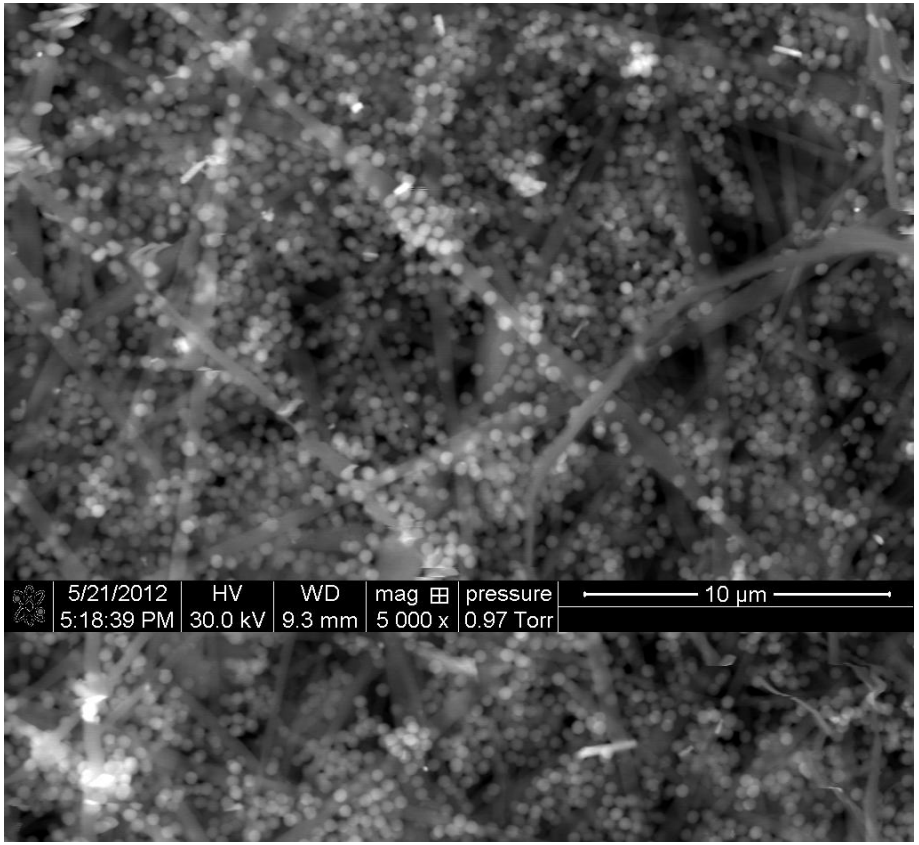
ZnO Nanorods

Nanomaterials Tested

Nanofibers
Composites



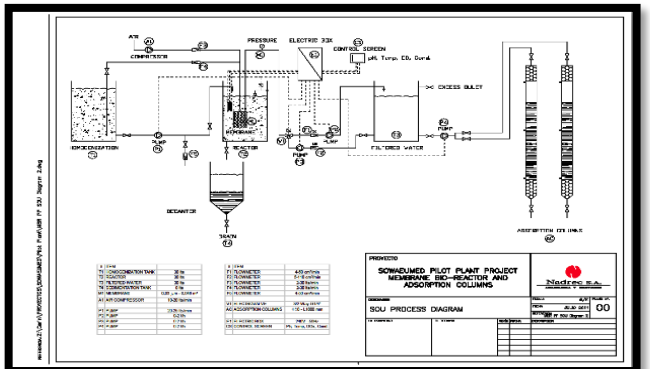
PLLA-SPION

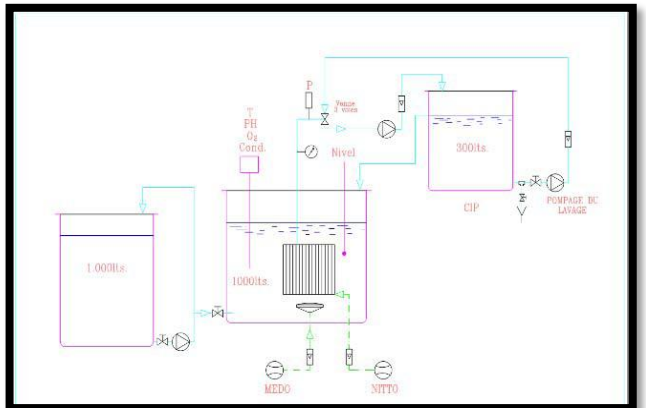


PAN-Fe3O4 NPs

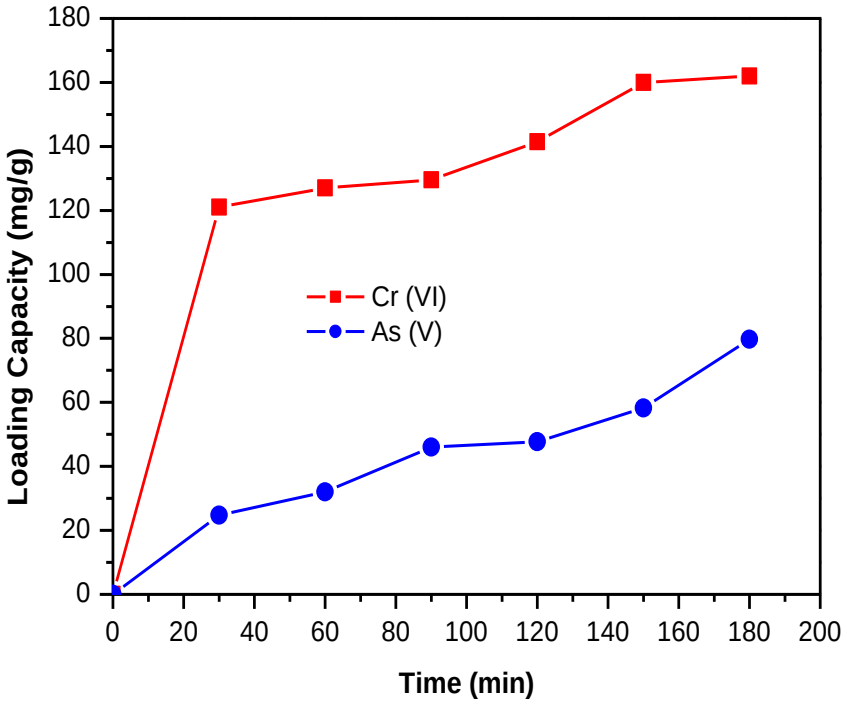
Pilot Plants Implications

Implementation of composite nanomaterials in pilot plant (Morocco and Tunisia under SOWAEUMED project).

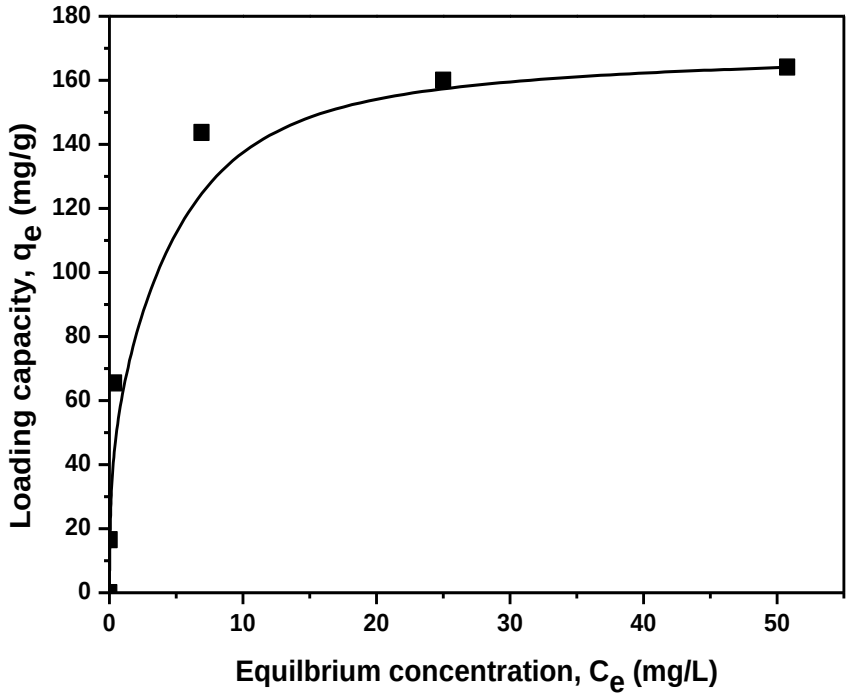




Pilot Plants Implications

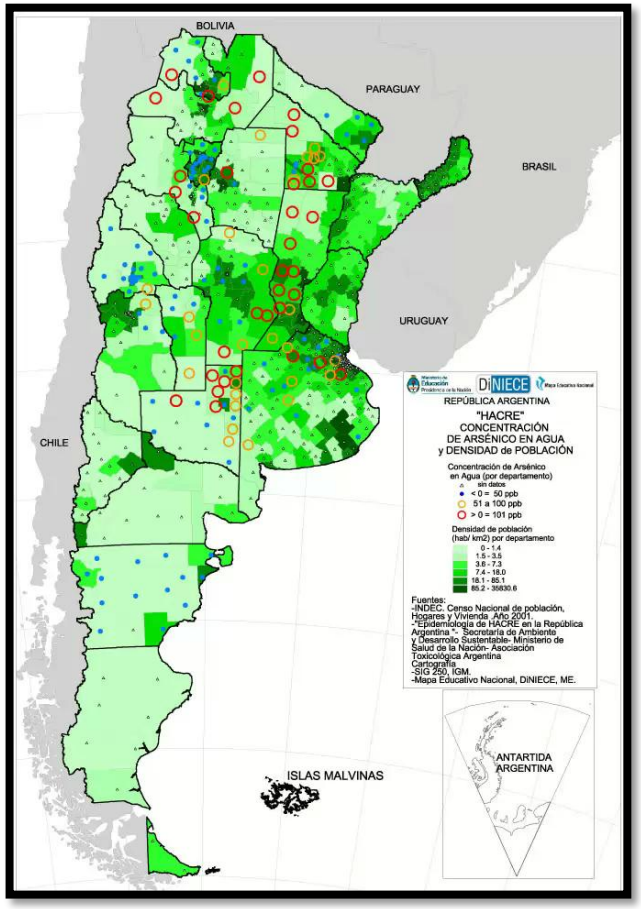


Cr(VI) removal from Tanning industry wastewater



Indigo Carmine removal from textile industry wastewater

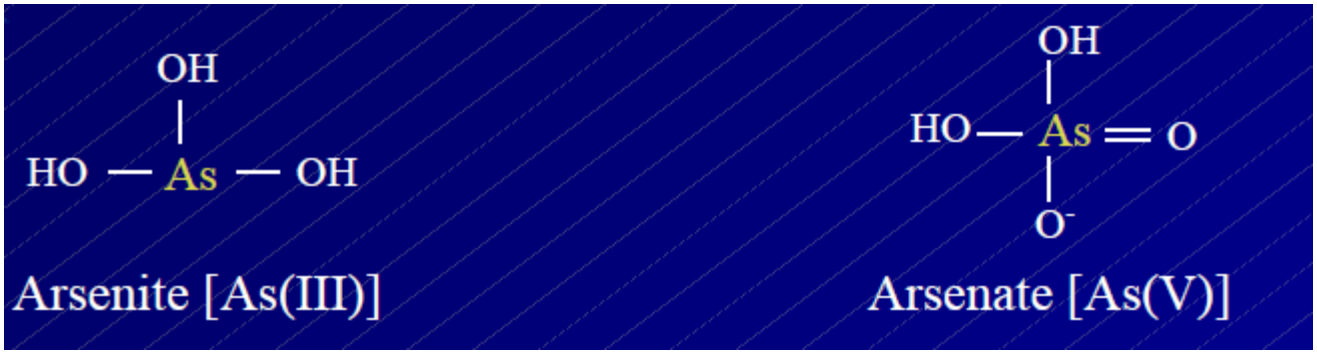
Mobility within EU-LA Project



Raul Ariel Procaccini Del Valle
INTEMA

- WHO limit: 0.01 ppm
- Argentina:
  0.1 to 0.8 ppm
  7 to 10% country population: mainly farm and native
- Source: geological and mining
- No government policies for cleaning out
- No investments for water remediation

Arsenic as pollutant

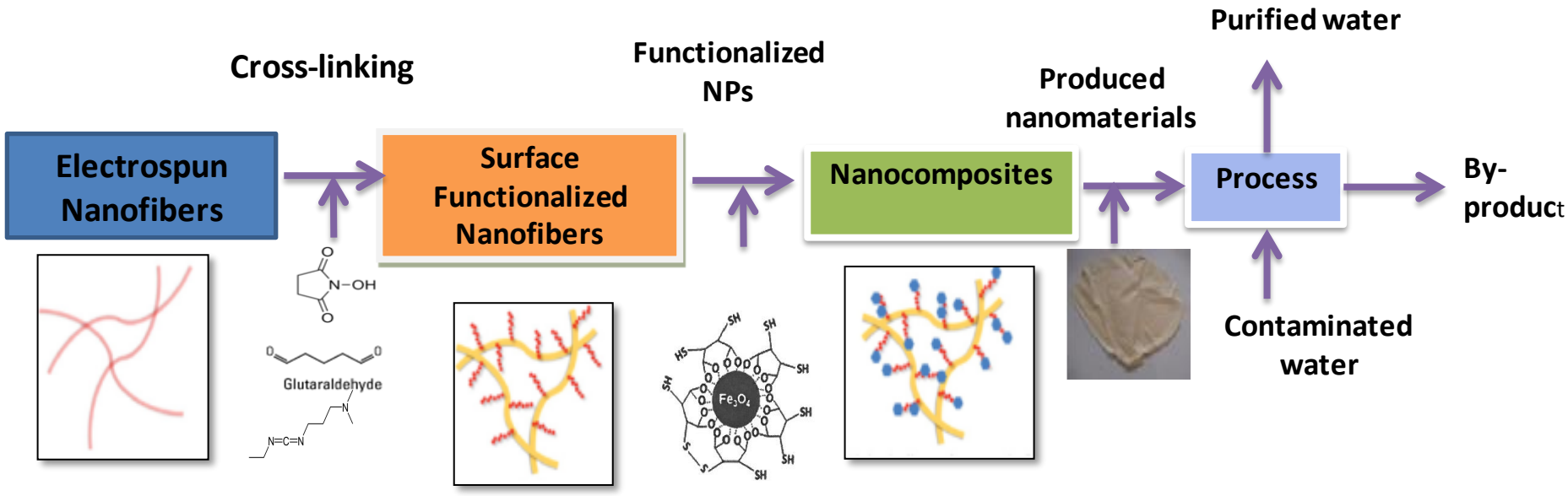


- the most common mobile species in ***water***, soil, and sediment.
- As(III) and As(V): introduced into the environment from natural sources

  (e.g., volcanic activity and weathering of minerals) and from anthropogenic activity (e.g., ore smelting, burning of coal, degradation of organo-arsenic pesticides).
- Highly toxic to organisms, including humans.
- Arsenite, being more water-soluble than arsenate, is more mobile and more available to organisms.

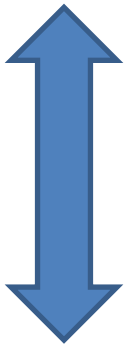
Mobility within EU-LA Project

The aim is to develop a process based on nanofibers composites for As(III, V) removal



Nanocomposites Design

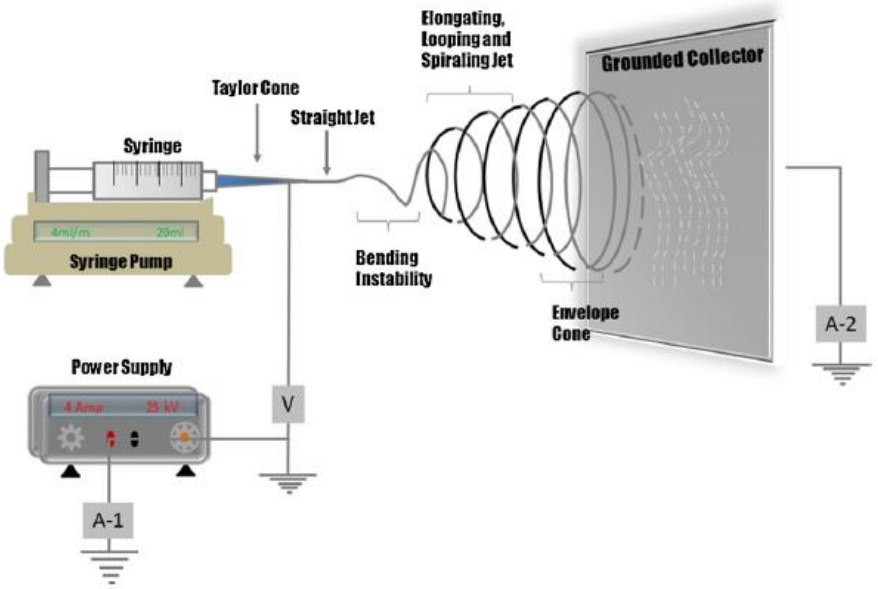
- Synthesis of nanofibers by electro-spinning
- Nanofibers functionalization (-NH_2, -COOH, etc)



- Synthesis of surface modified Nanomaterials (Fe_3O_4, Silica)-(-NH_2, -COOH, -SH)

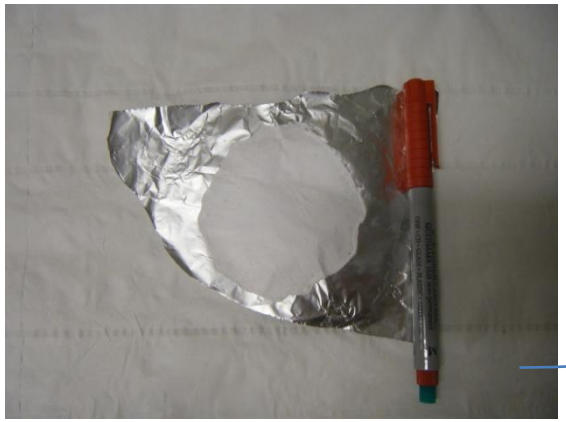
Fabrication of Nanofibers

- Poly acrylonitrile 10wt% in DMF (PAN/DMF)
- Electro-spinning: 1 mL h^{-1}; 10 kV, 10 cm
- Drying: 60°C in vacuum



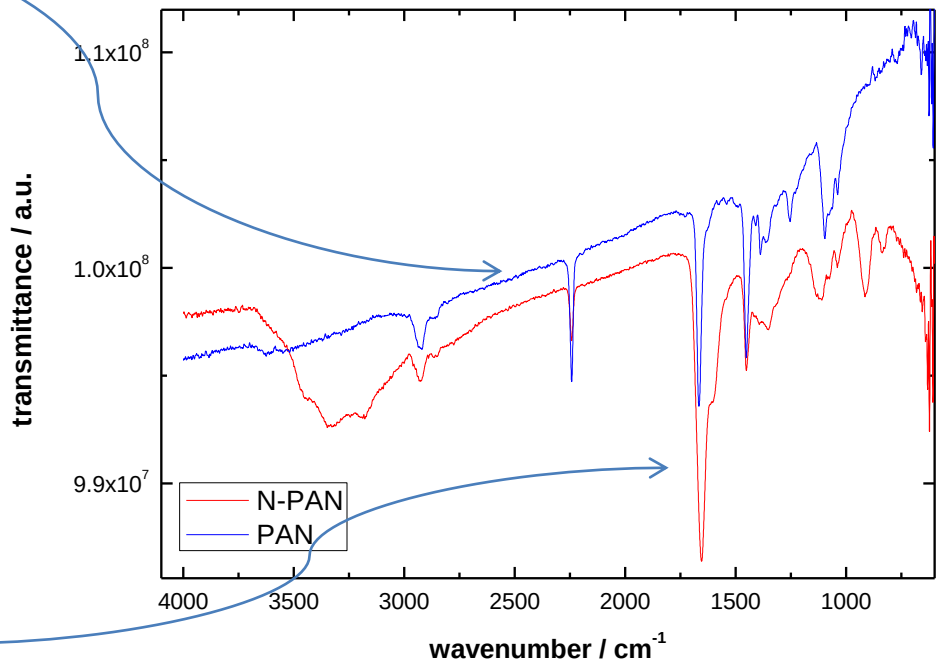
Characterization of NH_2-PAN

- FTIR and Conversion Number (Cn)

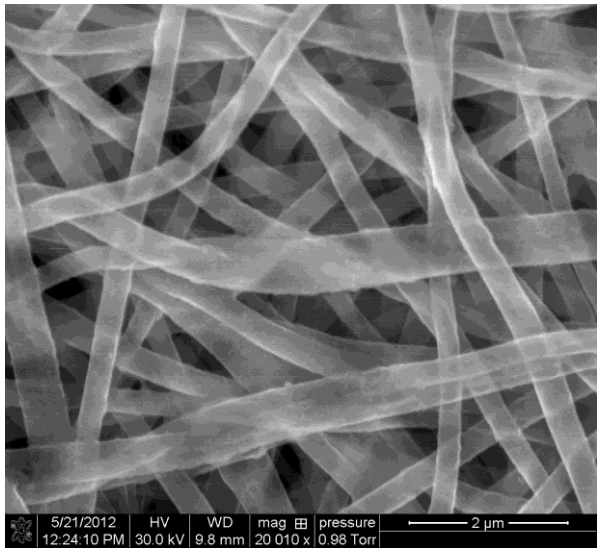


$$C_n = \frac{W_1 - W_0}{W_0}\frac{M_0}{M_1} \times 100$$

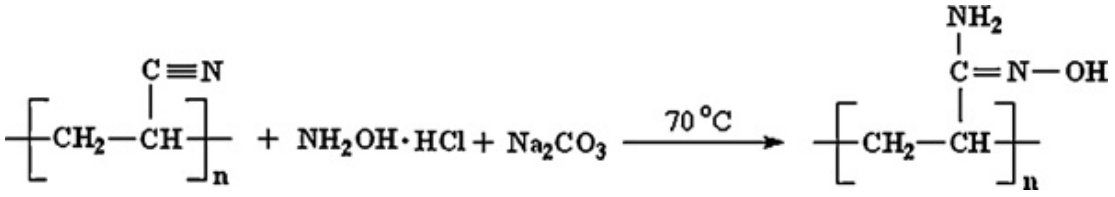
C_n = 13 – 45%

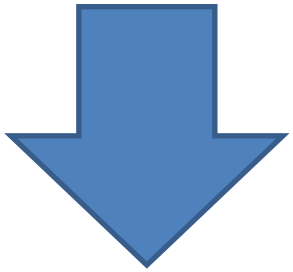


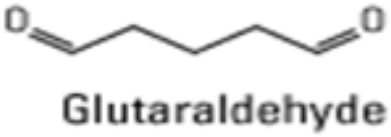
Cross-linking process



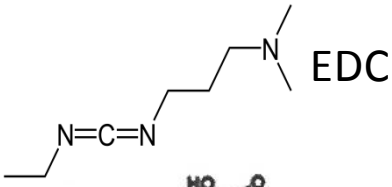
Functionalized PAN nanofibers





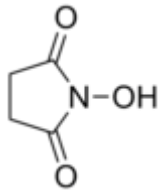


Crosslinking medium

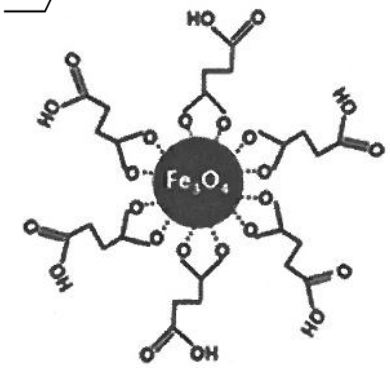


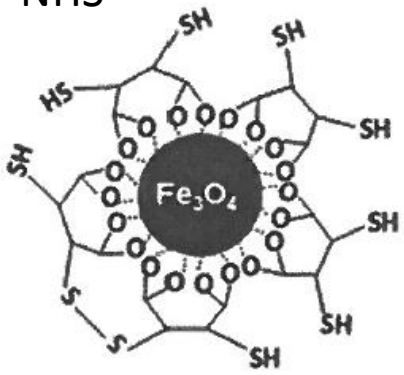
EDC

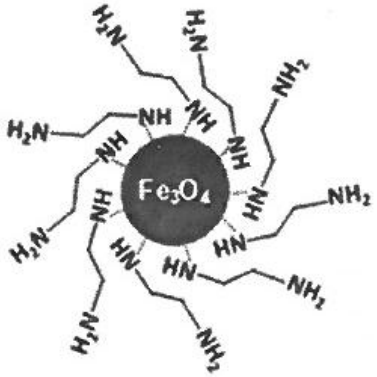
\+



NHS

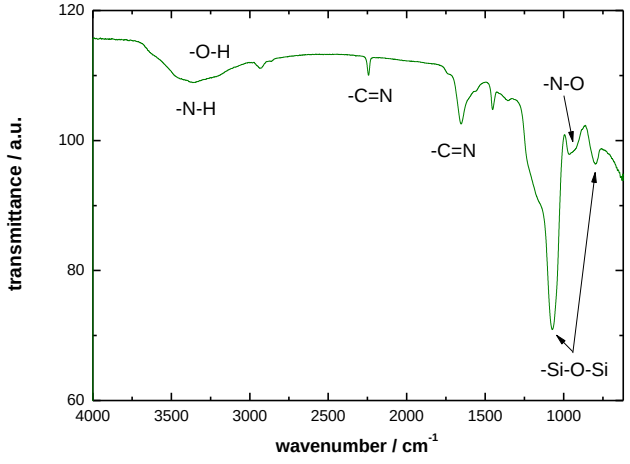






Characterization of NCs

- FTIR



- Nitrile: 2260 cm^{-1}
- Amino features:

-N-H: 3360 and 3286 cm^{-1}

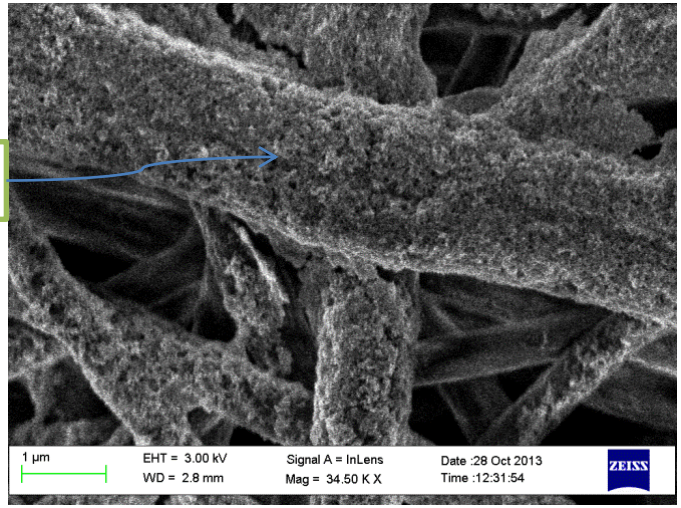
-N-O: ~920 cm^{-1}

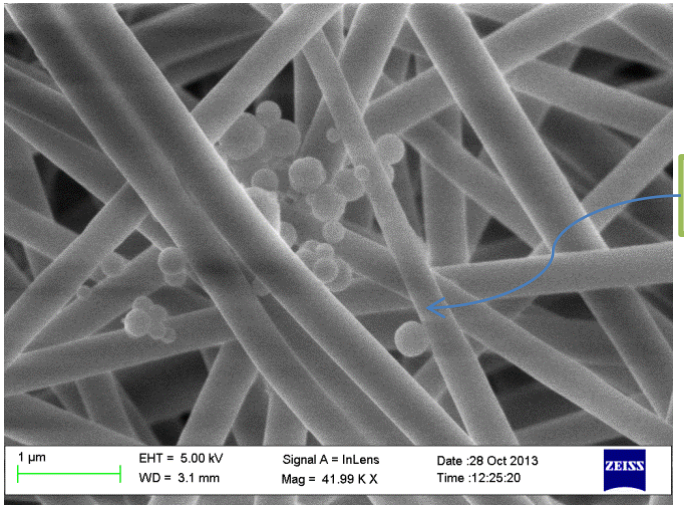
- Silica features:

-Si-O-Si: 1086 and 800 cm^{-1}

- SEM

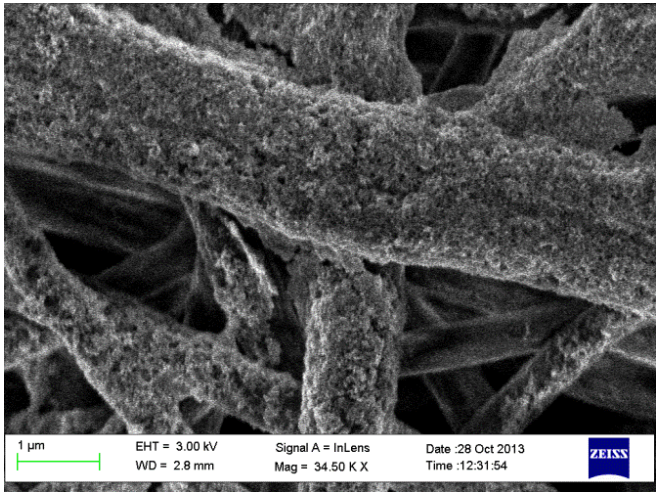
Fe NPs



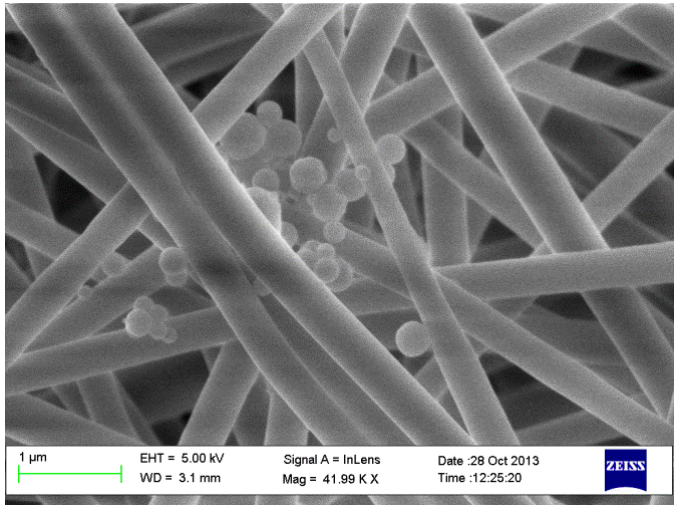


MP SiO_2

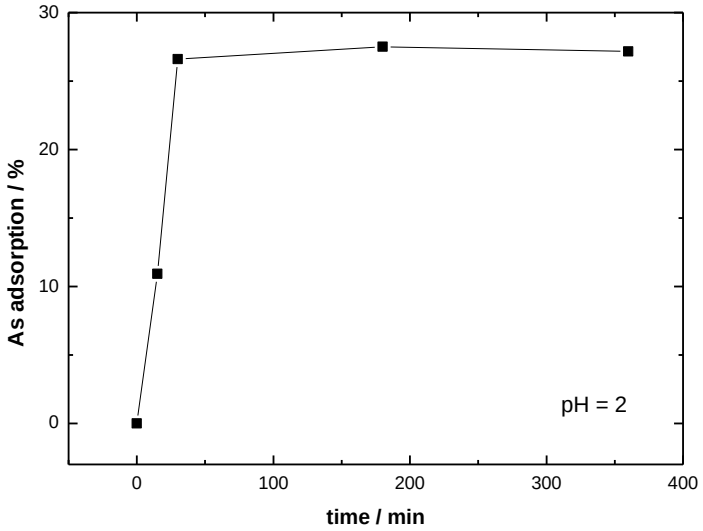
Adsorption tests for As (V)

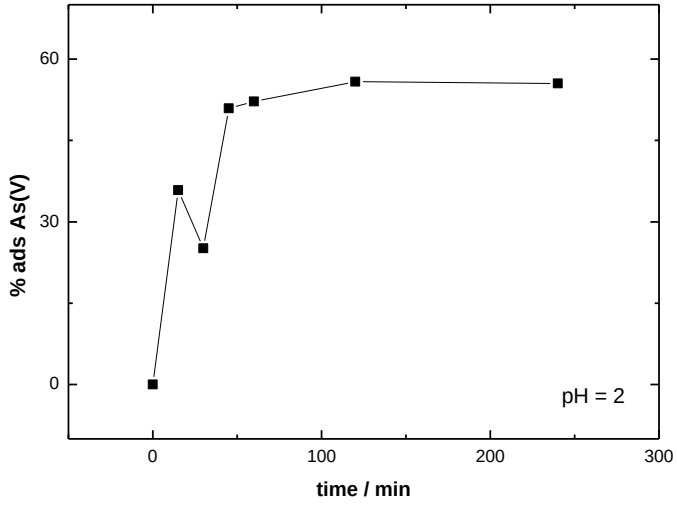


NH2-PAN/Fe3O4-SH



NH2-PAN/SiO2-NH2





Planned Activities

- Mechanistic Studies of the adsorption of As(V) and As(III)

- Adsorption studies of As(V) and As(III) onto nanofibers composites using column operation mode

- Fabrication of nanofibrous mats of polymer–oxide composite which are converted to pure oxide nanofibers by calcination

Thank you