



“Smart Nano-structured Devices Hierarchically Assembled by Mineralization Processes”

Project coordinator: **Dr. Anna Tampieri**

SMILEY aims to develop and apply a "bottom-up" approach to build nano-structured devices with smart, multi-functional properties. To this aim, nature is used as the inspiration for the development of an ensemble of Mineralization↔self-Assembly↔self-Organization processes (termed MIAO), which will be controlled to first generate elementary nano-sized building blocks, and then to direct their assembly.

These new devices will have the following applications:

i) Smart Air Filters for Capture of Nanoparticles

Development of 3-D porous matrices obtained through mineralization of self-assembling natural polymers (e.g. chitosan, cellulose, gelatine, fibroin) with apatite-like phases. These will be employed as protective devices for selective filtration of nano-particles. These filters will also be smart, having the ability to be activated under a magnetic field. This will increase the capture efficiency by magnetic and thermophoretic interference, and the filters will also show anti-bacterial/ bacteriostatic behaviour.

ii) Scaffolds for Dental Repair and Regeneration

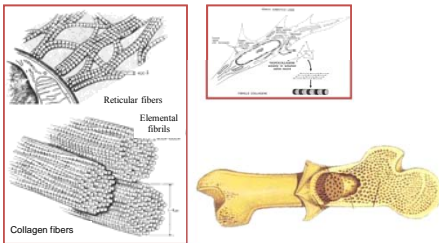
Development of bio-hybrid composites made of self-assembling natural polymers (e.g. collagen, alginate, chitosan and cellulose) mineralized with biomimetic hydroxyapatite (HA) nano-particles. The MIAO process will be directed to obtain bioactive and cell-conductive scaffolds for the repair and regeneration of human hard tissues such as bone, cementum and dentin.

iii) Fibre-Based Photovoltaic Devices

A new generation of dye-sensitized solar cells will be obtained using MIAO processes employing natural fibres (e.g. modified cotton, flax, wool, silk, fibroin) and mineral phases exhibiting photo-electronic properties (e.g.: SiO₄/GeO₄ apatitic-like phases, TiO₂, ZnO).

Biom mineralization

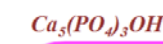
Bone tissue is a typical example of a mineralization process mediated by an organic matrix: collagen is synthesized then extruded by cell and finally self-assembled in the extracellular space before mineralization starting.



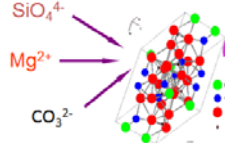
Mechanisms controlling Biom mineralization

- Chemical
- Spatial
- Structural
- Morphological

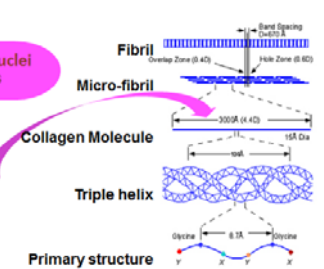
Inorganic phase



Nucleation of HA nano-nuclei on the collagen fibers



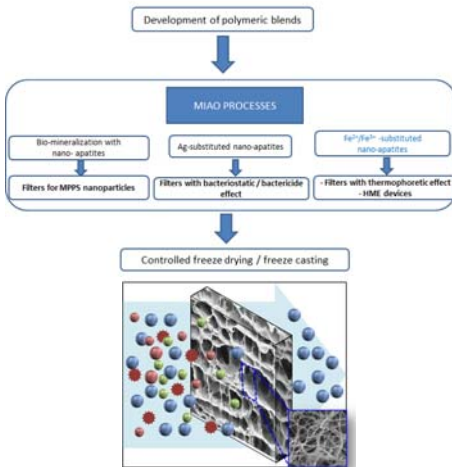
Organic/polymeric phase



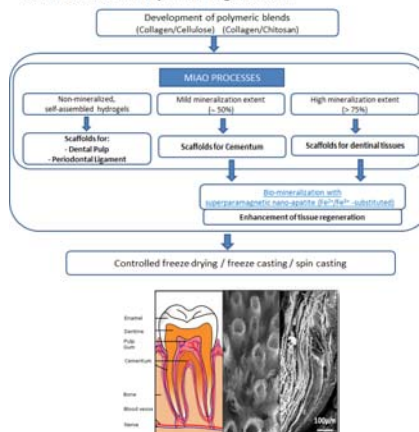
MIAO PROCESSES

Fibre self-assembling / self-organization / mineralization

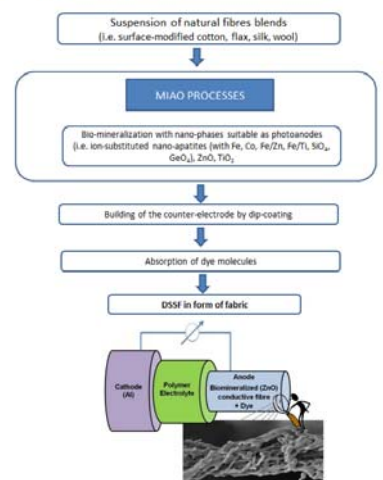
Smart Air Filters for Capture of Nanoparticles



Scaffolds for Dental Repair and Regeneration



Fibre-Based Photovoltaic Devices



Involved Partners

- ISTEC-CNR (BIO and ENERGY Group) and ISAC - CNR - I
- University of Leeds - UK
- Friedrich-Schiller University of Jena - D
- Fin-Ceramica Faenza SpA - I

- University of York - UK
- Laboratoire d'Evaluation des Matériels Implantables - F
- Institute of Natural Fibres and Med. Plants - PL
- Pollution Srl - I