



Ph.D. thesis vacancy in Material Sciences

Multi-physics and multi-scale investigation of the setting process of cements for bone regeneration

Place of work: MATEIS laboratory (web: mateis.insa-lyon.fr), located on the campus of La Doua. The student will be register as a Ph.D. student at the engineering school of INSA Lyon.

Duration: 3 years contract; start date to be discussed (ideal start during Fall 2019)

Funding: French ANR (SUN7 project)

Project Description:

More than 2 million bone grafting surgeries are performed every year in the world. Compared with conventional surgeries, minimally invasive procedures enable the implantation of the biomaterial through a small incision, offering several benefits (lower pain, fewer complications, quicker recovery...). However, these techniques require biomaterials that should be in an injectable viscous state for the duration of the injection and should then turn into a solid biomaterial to provide strength to the repaired bone. These specifications have led to the development of calcium phosphate (CaP) cements, representing a significant breakthrough compared with conventional bioceramics for bone repair.

Their setting and hardening are continuous processes, similar to the one of gypsum plaster and of cements used in civil engineering. Setting is always initiated by mixing one or several fine powders with aqueous solutions. The dissolution of the initial reactive powders results in the formation of viscous and moldable pastes, which properties evolve with time to form a monolithic ceramic. During the setting process, the physico-chemical, microstructural, and mechanical properties of the paste drastically evolve. This phase transition governs all functional properties of the cement but is still not fully understood.

The Ph.D. student will be involved in the SUN7 project aiming at **developing advanced experimental methods and characterization tools to in-situ monitor setting and hardening processes** at different scales (from the nucleation and growth of single crystals to the development of the micro- and macrostructures). Complementary quantitative approaches (physico-chemical, microstructural, and rheological + mechanical evolutions) will be used to draw a global picture and permit a thorough understanding of the structuring of a mineral material from a liquid to a solid state.

The setting process of 2 materials will be successively investigated: the Ph.D. work will start with the development of experimental methodologies using gypsum plaster as a model material. Then, skills and developed methodologies will be used to study the setting reaction of a CaP cement.

The Ph.D. work will also include the presentation of results at international conferences and the writing of scientific articles for peer reviewed journals.

Candidate profile: a background in Material Sciences is required; knowledge in Ceramics / Inorganic Materials / Inorganic Chemistry / Cements or Hydraulic Binders will be a plus.

The candidate should also demonstrate the will to work in a multi-disciplinary research team.

Application or further information:

Please send a **motivation letter** as well as **your CV** to Solène Tadier and Sylvain Meille (solene.tadier@insa-lyon.fr; sylvain.meille@insa-lyon.fr).

Please indicate "SUN7 - Application for Ph.D." as the subject line of your e-mail.