# Polytech network form for PhD Research Grants from the China Scholarship Council

This document describes the PhD subject and supervisor proposed by the French Polytech network of 14 university engineering schools. Please contact the PhD supervisor by email or Skype for further information regarding your application.

| Supervisor information | |
|---|---|
| **Family name** | REKIK |
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| **Lab name** | Gabriel LaMé |
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| **Polytech name** | Polytech Orléans |
| **University name** | Orléans |
| **Country** | France |

| PhD information | |
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| **Title** | **Developpement of a numerical tool for simulation of multi-scale behaviour of human tissue** |
| **Main topics regards to CSC list (3 topics at maximum)** | Biomaterials and polymer materials, Biomedical engineering, Tissue engineering |

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| **Required skills in science and engineering** | Homogenization techniques, nonlinear mechanical behaviour, finite elements simulations |

# Subject description (two pages maximum)

Understanding the mechanical response of human tissues is essential in the development of computational tools to enable physically based simulations for realistic applications in the medical and cosmetic fields. This includes the planning of surgical interventions, the design of biocompatible prosthetic devices and implants, the anti-aging cream preparation and the quantitative evaluation of different medical treatments with respect to faster healing of diseased and damaged tissue.

Mathematical modeling in general and the coupling between nonlinear homogenization techniques and finite element (FE) method in particular are crucial tools in understanding the mechanical response of human tissues. Specifically, numerical homogenization can be used in simulations of connective tissue (bone, tendon) or cutaneous membrane (skin) accounting for a great number of parameters at different levels such as the nonlinear behaviour of the different constituents (viscoelasticity, elasto-viscoplasticity, damage, aging) and either their morophology and distribution.

To the best of our knowledge few works deals with nonlinear homogenization techniques (association of linearization and linear homogenization steps) applied to the human tissue allowing the prediction of its overall and local behaviour. To this end, the objective of this thesis is to develop a numerical tool based on nonlinear homogenenization techniques (nonlinear periodic homogenization and/ or mean-field homogenization techniques) in order to assess the macroscopic and local behaviour of human tissue (mainly skin), its time-dependency, effect of morphological and/or distribution changes over time induced for example by hydration rate or aging or other phenomenan.

To assess the accuracy of the multi-scale developed numerical tool, comparisons will be made between numerical results and experimental ones provided by the literature.