**PhD position at the Center for Biomedical and Healthcare Engineering,**
**ARMINES/Mines Saint-Etienne – Laboratoire Georges Friedel (UMR CNRS-5307)**

# CHARACTERIZATION OF DEFORMATION AND RUPTURE MICRO-MECHANISMS IN AORTIC ANEURYSM WALL

**Keywords**: Aortic aneurysm, aneurysm rupture, microstructure analysis, damage mechanisms, microstructure segmentation

**Academic context**: This PhD position is part of the interdisciplinary AArteMIS - Aneurysmal Arterial Mechanics: Into the Structure - project (2015-2020) awarded to Pierre Badel (www.emse.fr/~badel) under the European Research Council Starting Grant scheme (http://erc.europa.eu/starting-grants). His group at Centre Ingénierie et Santé (a research center of Mines Saint-Etienne) focuses on carrying out fundamental investigations in the domain of arterial mechanics, especially aneurysm rupture in collaboration with vascular surgeons of Saint-Etienne University Hospital. The AArteMIS project also involves the 3SR Lab (Grenoble) for advanced analysis of the microstructure of complex materials.

**Scientific context**: The rupture of an Aortic Aneurysm (AA), which is often lethal, is a biomechanical phenomenon that occurs when the wall stress state exceeds the local strength of the tissue. Current understanding of arterial rupture mechanisms is poor, as the physics taking place at the microscopic scale in collagenous structures remains an open area of research. Understanding, modelling, and quantifying the deformation micro-mechanisms which drive the macro-scale mechanical response of such tissues and locally trigger their rupture represents the most challenging and promising pathway towards predictive diagnosis and personalized care of AA.

**Project summary**: Our group was recently able to detect, in advance, at the macroscopic scale, rupture-prone areas in bulging aneurysmal arterial tissues. These state-of-the-art results indicate that rupture occurs at a localized strain concentration. The next step is to investigate in detail the extreme condition where the fibrous microstructure is approaching rupture, in order to **elucidate and quantify the mechanisms controlling the rupture response**. All along the project, the successful applicant will collect images of the microstructure of human aneurysm specimens using multiphoton confocal microscopy and a specific testing bench. A method will be developed for the analysis of the 3D images within the goal to characterize the evolving fibrous microstructure of the arterial specimens. This includes methods (i) for the segmentation, and the detection of fibers and (ii) for the quantitative analysis of fiber orientations, densities, curvatures, contacts… This will allow proper analysis and description of the microstructure's deformation up to rupture.

**Student profile**: mechanical engineering or material science and engineering. Background in 3D image analysis, and/or fibrous material analysis will be appreciated. Motivation for work at interface between experiments and computer analysis will also be appreciated.

**Administrative aspects**: The employer is Armines, linked by state-approved agreements to Mines Saint-Etienne, one of the most prestigious engineering schools in France. This PhD is funded for 36 months, starting in Fall 2015 (Net salary, including social security ~ 1700 €/month).

If you are interested, send a curriculum vitae, a cover letter describing previous research experience and interests, the names and contact information of two references. Please, submit via email with "ERC AArteMIS PhD1" on the subject line to Pierre BADEL, PhD (badel@emse.fr).