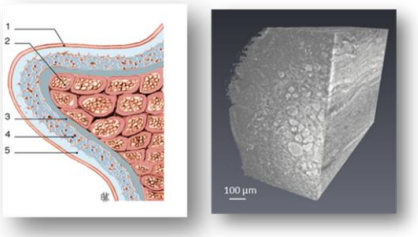
PhD Position - Experimental Mechanics of Materials/Structures

"3D imaging of vibrating fibrous structures by synchrotron X-ray microtomography: application to vocal tissues"

Location : **3SR Lab**, CoMHet team, Grenoble, France
lucie.bailly@3sr-grenoble.fr, laurent.orgeas@3sr-grenoble.fr, sabine.rollandduroscoat@3sr-grenoble.fr

Collaboration : **GIPSA-lab**, VSLD team, Grenoble, France (Nathalie.Henrich@gipsa-lab.fr)
ESRF ID19 beamline, Grenoble, France (boller@esrf.fr)

Project summary



Scheme and imaging of vocal-fold fibrous microstructure

The vocal folds are soft multi-layered laryngeal tissues, composed of collagen and elastin microfibrils' networks and owning remarkable vibro-mechanical performances. However, the impact of these tissues' histological features on their mechanical behavior is still poorly known. This is ascribed to their challenging experimental characterization at the scale of their fibrous networks. Since 2015, the 3SR and GIPSA laboratories together with Grenoble CHU and ESRF are conducting research to: (i) investigate the vocal-fold 3D fibrous architecture and micromechanics using synchrotron X-ray microtomography and phase contrast imaging mode; (ii) to use these data for the mimetic design of fibrous polymeric biomaterials with tailored structural and biomechanical properties (ANR MicroVoice).

The current PhD project is in the direct continuation of these works: this will concern **the study of the 3D strain-induced microstructure evolutions of such biomaterials, once subjected to mechanical vibratory loadings encountered during human phonation**. Focus will be given to artificial fibre-reinforced polymers enduring forced sinusoidal oscillations in a first step, and self-sustained oscillations in interaction with an airflow in a second step. More precisely, three phases are planned :

1 – first, characterization of the macroscale vibratory performances of a series of (hydro)gels reinforced by networks of polymeric fibres (micro- and nanometric diameters), and molded in a realistic vocal-fold geometry. This phase relies on aero-acoustic measurements combined to optical imaging of the vibrating surfaces.

2 – then, investigation of the 3D vibrating properties of such materials down to the scale of their fibres, using RX synchrotron microtomography. This phase relies on the development of a set-up dedicated to the synchronization of the acquired RX images to the (quasi-)periodic motion of the materials.

3 – finally, quantification of the impact of an acoustical load on the multi-scale properties of the vibrating structures so as to better understand the effect of a simplified vocal tract on the phonatory source.

Location and practical aspects

The successful applicant will be hosted by the **laboratory Soils, Solids, Structures, Risks** (**3SR**, www.3sr-grenoble.fr/) in the "CoMHet" team. A part of his/her work will also be conducted in the **Images, Speech, Signal and Automation Laboratory** (**GIPSA-lab**, www.gipsa-lab.grenoble-inp.fr/). This project will benefit from a collaboration existing between researchers in mechanical engineering, voice production and X-ray synchrotron imaging from ESRF (ID19 beamline).

The PhD fellowship offer is available from **November 2019** (possible adjustments of this starting date if need be) for a period of **3 years** (financial support acquired from French Ministry of Higher Education and Research).

Applications

Candidates holding a master degree or equivalent in solid mechanics, material and structural engineering are expected. Specific skills in dynamics of composites, vibromechanics, and experimental mechanics will be strongy appreciated. Additional knowledge in acoustics and/or biomechanics of soft tissues will be interestingly examined. Interested candidates should send their **CV**, a **cover letter** and **official transcripts of the last two years** before **2019, May the 19th** to Lucie BAILLY, lucie.bailly@3sr-grenoble.fr, (+33) (0)4 76 82 70 85.