**PhD proposal LGP2 – LRP - Campus Saint-Martin d'Hères (38400)**

# Intensification of gas/liquid mass transfer by ultrasound - application to ozone reactive de-inking and/or bleaching of lignocellulosic fibres with oxygen or ozone (InTrUS project)

## Subject description

The research problem is the use of ultrasound to increase mass transfer in liquid phase of reactive gases used in unit operations of paper processes. Beyond the transfer, the action of ultrasound on the reactivity of these gases and/or on the generation of oxidizing species within the liquid phase will also be investigated. Attention will also be paid on possible interaction between ultrasound and fibres. The objective is therefore the intensification of processes in the aim of improving the overall performances (effluent and fibre quality) while reducing the quantity of reagents used and the environmental impact of discharges.

The main work package (WP) of the thesis work will be:

**- WP1: Bibliography** on the subject with two main parts: (i) gas/liquid transfer and ultrasound and (ii) implementation of oxygen and ozone in paper processes.

- **WP2: Characterization of gas/liquid contactors** with and without ultrasound. Determination of volumic transfer coefficients and specific surface area of exchange by controlled model systems (e.g. oxygen in a sulphite solution) and of the solubility of ozone and oxygen in different waters (tap water, paper mill model water, different pH values, etc.) and for different operating conditions (e.g. flow rate) and ultrasonic wave emission (frequency, power).

- **WP3: Determination of gas/liquid reaction regimes**, for the self-decomposition of gases into water and for reactions with contaminants in paper process water. Reaction kinetics will be studied, and an approach based on adimensional numbers with integration of ultrasound characteristics will be considered.

- **WP4: Incorporation of virgin and/or recovered cellulosic fibres** in suspension at low consistency (1-3%) with and without ultrasound. The use of ultrasound coupled with the introduction of gas may be carried out upstream or in the reactor containing the fibres. The performances on the optical (whiteness, ...) and physical properties (tear resistance, ...) of the fibres and on the quality of the effluents (COD, ...) will be characterised.

- **WP5: Valorisation of the results** in the form of articles, conference proceedings and thesis manuscript.

## Location et practical information

The PhD student will be supervised by Professors **Marc Aurousseau** (Grenoble INP / LGP2) and **Nicolas Gondrexon** (UGA / LRP). The research work will therefore be carried out within the framework of a collaboration between two laboratories, LGP2 (Laboratory of Pulp and Paper Science and Graphic Arts, http://pagora.grenoble-inp.fr/fr/recherche) and LRP (Rheology and Processes Laboratory), located on the Scientific campus of Saint-Martin d'Hères close to Grenoble, 150 metres from each other and providing complementary expertise and experimental means (reactors, ultrasound devices, characterisation of gaseous, liquid and solid phases, etc.). The site's shared platform resources could also be used (high-speed camera for example) and collaborations with other French laboratories are envisaged.

## Skills of the candidate

The candidate recruited must have a Master 2 or engineering degree in Process Engineering. Experience in gas/liquid transfer and/or in the implementation of ultrasonic waves would be appreciated, as well knowledge of cellulosic fibres. The expected skills are: taste for the research approach, experimenter qualities, team work on a multidisciplinary subject, autonomy, very good level in English, writing. For foreign student, a B2 level in French will be appreciated. He/she will be enrolled in the I-MEP2 doctoral school.

## Salary

Within the framework of a doctoral contract with Grenoble INP: 1400 € net/month. Possibility to work shifts or the RES label allowing an additional salary.

## To apply

Send CV, transcripts and cover letter with motivations by e-mail to Marc Aurousseau (marc.aurousseau@grenoble-inp.fr) et Nicolas Gondrexon (nicolas.gondrexon@univ-grenoble-alpes.fr). **Deadline: May 20, 2020.**