Ph.D. position (36 months) immediately available
@ University of Nice Sophia Antipolis (France) & Avantium Chemicals Company (The Netherlands) & INERIS

**HUMins as Green and Sustainable precursors of eco-friendly building blocks and materials**
**HUGS - project**

**Thesis subject:**
“Exploring the humins universe: from controlled biorefinery process to well defined properties and applications”

**Context:**
The production of new versatile carbon-based chemicals and materials from biomass resources can provide a unique alternative to avert massive use of petroleum-based chemicals. Biomass from plant materials is the most important feedstock for food, feed and non-food applications. The conversion of lignocellulosic biomass into fuels and chemicals entails scientific and technical challenges covering different fields including catalysis and chemical engineering.

The growing interest to develop sustainable biomass conversion processes at large scale has been exemplified by the SME Avantium, a CleanTech top 100 company. Avantium operates a pilot plant (24/7 since 2011) to convert carbohydrates into Alkoxyethylfurural (RMF) compounds, further processed to a new class of furanic building blocks based on FDCA denoted as YXY. In the FDCA production process two main classes of side products are produced: humins and levulinic acid/alkyl levulinate.

Avantium will start constructing a 5 ktons/year FDCA demonstration plant in Europe in 2016. This plant will produce substantial amounts of humins and levulinates starting from 2018. So, it is of utmost importance that higher-added value outlets for these side products are developed. Future replacement of PET by PEF will require multiple 500 ktons/year FDCA plants concomitantly generating > 100 ktons/year of side products. Despite the urgent need to raise these scientific and technological challenges at a European level, the state of the art regarding the valorization of side stream biorefinery products is relatively weak. Recently, the EU has granted the HUGS EID project with 5 PhD positions to fill this void.

**PhD project summary:**
The main objective of the PhD project is to increase the knowledge about the chemical and physico-chemical (catalysis, temperature, pH, time) parameters that govern the mechanism of humins formation under the conditions used in Avantium’s pilot plant process. Subsequently, the project will focus on the overall characterization of humins macromolecules, starting from identification of their chemical structure and functional groups, their reactivity, accompanied by physico-chemical characterizations (solubility, viscosity, thermal and solvent stability). Leaching issues and ecotoxicological aspects will also be emphasized.

The PhD applicant will be in charge of a four-fold axis project:
1. Humins formation: effect of composition of feedstock, process conditions (time, temperature, catalyst concentration) and structure / property relations of raw humins.
2. Humins properties: application of rheological models to determine flowing behavior, thermal stability, VOC release, stability against hydrolysis. Optimization of parameters and testing the potential of humins in novel applications such as liquid fuels and solid resins. Raw as well as modified humins will be tested.

3. Leaching experiments for the humins in novel fuel and resin applications (total amounts, identification of individual molecules, dependency on temperature and solvent system (water, salt water, acidic water, organic solvents)).

4. Optimizing products based on previous results.

We are looking for:
An (organic) chemist with preferably knowledge of chemical engineering as well as chemical analysis. The candidate should be motivated and self-driven to work together with 4 other PhD’s in a dynamic industrial environment for half of the time while the other half will be spent at the collaborating institute(s). The candidate should be computer literate, with good oral and written English language skills. This work, with a substantial experimental part, will offer the opportunity to master aspects of pilot plant processing and to control the parameters influencing the humins formation and composition. Also various physical and chemical characterization tools for biobased materials will be used (NMR, FT-IR, DSC, TGA, HPLC-MS). Therefore, it will involve multiple interactions with chemists and engineers to deal with synthesis, reaction mechanism, catalysis, evolution of molar mass, polymerization, viscosity and degradation studies.

Hosting team:
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