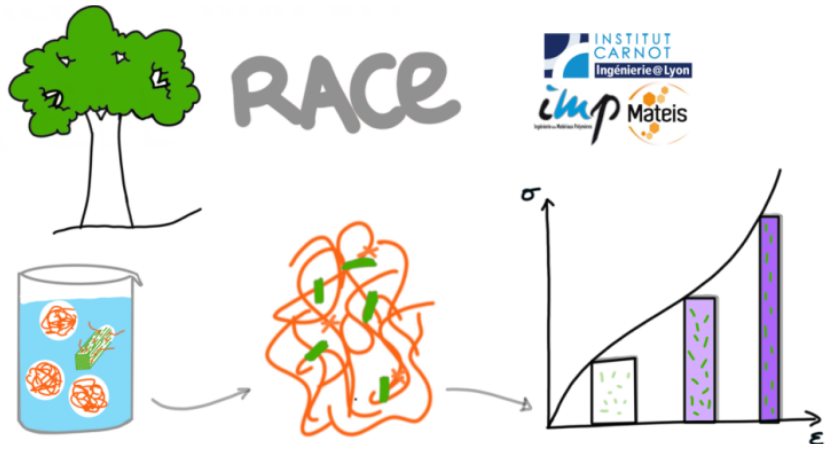
RACE : Rubber filled with nAnoCEllulose, from colloidal assembly to material properties

Keywords: nanocellulose, colloid, latex, surface chemistry, filled elastomers, mechanical behavior, microstructure



Project goal and methodology. Nanocelluloses are generating a strong interest as they can be industrially produced at a reduced cost from widely available biomass, and thanks to their unique features, which make them a promising reinforcing filler for nanocomposites. [1] At the industrial scale, nanocomposites are mostly rubbers, and are employed in tires, sold, seals, pipes or floor coatings. In the frame of a recent joint research project with Michelin, [2] we have proven that nanocellulose is effective as a reinforcing filler in a similar way than silica and carbon black currently do in industrial formulations. In this project, we will develop a low energy and scalable process to obtain those materials from industrial colloidal suspensions of nanocellulose and rubber latex, and their mechanical properties will be evaluated to highlight original behaviors specific to nanocellulose fillers.

The project is divided in three successive parts: surface modification of the colloids to tune their interaction and the properties of the resulting materials (colloids will be characterized by FTIR, CP MAS, DLS, titration, electron microscopy), assembly of the colloids to form a dewatered solid with a controlled microstructure (DLS, rheology, SEM, TEM, X-ray scattering), investigation of the resulting material mechanical properties (tensile test, DMA) considering their microstructure and interactions.

[1] Kontturi, E., Laaksonen, P., Linder, M. B., Gröschel, A. H., Rojas, O. J., & Ikkala, O. (2018). **Advanced materials through assembly of nanocelluloses**. Advanced Materials, 30(24), 1703779.
[2] Fumagalli, M., Berriot, J., De Gaudemaris, B., Veyland, A., Putaux, J. L., Molina-Boisseau, S., & Heux, L. (2018). **Rubber materials from elastomers and nanocellulose powders: filler dispersion and mechanical reinforcement**. Soft matter, 14(14), 2638-2648; **Rubber composition comprising cellulose** Fumagalli M., Heux L., Boisseau S., Berriot J., de Gaudemaris B., Veyland A., Seeboth N. (2014). International patent WO/2014/096188 & WO/2014/096192

Location & Funding. The PhD will work at the IMP Lyon 1 laboratory in collaboration with MATEIS INSA lab, and will be co-supervised by Matthieu Fumagalli and Florent Dalmas. The 3-yr PhD can start from January 2021 and the monthly salary is 2 135,00 € gross. The project RACE is funded by the Carnot Institute Ingenierie@Lyon.

Application. We are looking for a student with a master degree in chemistry or material science and with a background in polymer science. We are seeking for someone open-minded, rigorous and with a strong interest for the experimental work and the subsequent results analysis. Applications have to be sent by email to matthieu.fumagalli@univ-lyon1.fr and florent.dalmas@insa-lyon.fr and shall include a CV, a short statement on the applicant motivation, and a reference contact.