MATERIALS SCIENCE AND TECHNOLOGY

DISAT - Shaping Layer-by-Layer coated natural fibers into green, fire safe and lightweight insulating materials

Funded By	Dipartimento DISAT
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Context of the research activity	Societal demand towards the concepts of circular bioeconomy is reflected by the need for new sustainable materials produced by green processing routes. The PhD project addresses this challenge by exploiting the potentialities of a novel approach for the production of green biobased lightweight materials from layer-by-layer (LbL) functionalized natural fibers. Lignocellulosic waste is selected as a source for natural fibers. Electrostatic complexation of bio-based components is used a green approach to material development. The PhD position is linked to the scientific activities of the PRIN 2022 PNRR - GAIA project (CUP: E53D23017860001). Finanziamento dell'Unione Europea – Next Generation EU–missione 4, componente 2, investimento 1.1.importo rendicontato € 49088,97".
Objectives	The aim is to produce lightweight fiber-based materials capable of combining high mechanical strength, excellent thermal stability and flame retardancy thanks to the achieved control over the nano and micro structure. The main research objectives of this PhD thesis include: • To understand the phenomena controlling the LbL assembly on natural fibers. The aim is to control the composition, interaction and assembling conditions in order to correlate them with the achieved structure and properties. • To finely tune the LbL composition in order to achieve the desired thermal insulation, flame retardancy and mechanical properties. LbL assembled coatings conventionally show unique set of properties ascribed to their composition and molecular scale interactions. For example, polysaccharide/polyphosphate assemblies show improved thermal stability and flame retardancy. Conversely, nanoparticles-based assemblies can yield impressive mechanical properties with high specific modulus and tensile strength. The presence of salt and water can be further employed to control plasticity allowing for hybrid materials encompassing ionic interaction but capable of extensive deformation upon loading. • To control the density of the final material by exploiting different processing

	routes. Once prepared, the coated fibers can be foamed into the desired functional materials by exploiting various approaches. To this aim, freeze-drying or surfactant aided processes will be employed for the production of foams with controlled pore size and distribution. A thermobonding process exploiting thermoplastic fibers is also foreseen. The effects of foam density and structure on the achieved mechanical, flame retardant and thermal insulation properties will be thoroughly investigated.

Skills and competencies for the development of the activity	Materials science, paper and pulp technology, chemistry, colloids and surface science represent different possible backgrounds for candidates for this PhD topic. Candidates should be highly motivated to learn through advanced research. Expertise in polyelectrolyte processing and assembly as well as polymer characterization is a plus. Practical attitude for the lab activities and problem solving skills are also appreciated.