Eco-friendly elaboration by electrospinning of bio-inspired adhesive membranes

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Adhesives industry, as other sectors of chemistry, needs research and development allowing the fabrication, with a green chemistry approach, of more environmentally friendly products. In this context, the challenge of this PhD is to develop an original class of adhesive membranes reducing the environmental impact and mainly dedicated for biomedical applications. Inspired by wet-adhesion encountered in the nature (Fig. 1a), researchers developed adhesive hydrogels based on the use of molecules bearing catechol or galloyl moieties having the property to interact efficiently with various substrates thanks to supramolecular interactions (Fig 1b). Among the avalaible bio-based molecules, tannic acid (TA) (inset of Fig. 1c) has been used as an efficient supramolecular cross-linker for the elaboration of adhesive, tough and self-healing hydrogels based on synthetic polymers[1] or natural polysaccharides.[2] However, the preparation of such hydrogels is not an easy task due to the high reactivity and fast kinetic between TA and the used polymer.

The goal of this PhD is to develop an original strategy allowing the straightforward elaboration of TA-based supramolecular adhesive membranes from electrospinning, a process allowing the production of nanofibers from a polymer solution subjected to a high electric field. The resulting nanostructured membranes will be composed of intertwined nanofibers each embedding one of the supramolecular reactants (Fig. 1c-f). Recently, we validated our strategy and also demonstrated that supramolecular TA nanofibers can be obtained by electrospinning (Fig. 1c-d).[3] Thus, membranes having different compositions (TA + various kinds of polymers and metals for potential enhanced cross-linking) and morphologies (fiber diameter, structuration of the membrane through its thickness…) will be produced using water as solvent and characterized by SEM. The rheological and the thermo-mechanical properties will be asssed in terms of cohesive and adhesive energy with several kinds of substrates under tensile and shear fracture modes. Finally, the self-healing properties of theses membranes will be characterized as well.

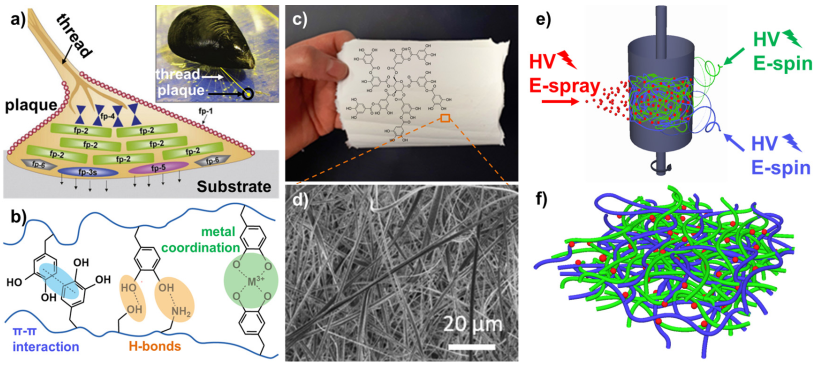

Figure 1: *a) Organization of proteins in the plaque of a mussel. b) Examples of interactions found for mussel's wet adhesion.[4] c) Photography and d) SEM picture of an electrospun TA membrane.[3] e) Multiple electrospinning setup for the elaboration of f) composite membranes made of intertwined nanofibers and microparticles.*

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