MATERIALS SCIENCE AND TECHNOLOGY

DISAT - Advanced functional nanofibrous materials by green electrospinning

Funded By	Dipartimento DISAT
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Context of the research activity	Electrospinning is a versatile fiber-production technique that uses a high-voltage electric field to draw a polymer solution or melt into ultrafine fibers, typically from tens of nanometers to a few micrometers in diameter. This process yields nonwoven mats with exceptionally high surface area, tunable porosity, and the capacity to incorporate functional additives. Such unique features make electrospun materials highly attractive for applications in wound healing, tissue engineering, drug delivery, filtration, sensing, energy storage, and flexible electronics. Increasingly, research is focusing on developing environmentally friendly electrospinning processes and materials, emphasizing water-based formulations, renewable polymers, and energy-efficient stabilization methods to produce sustainable, high-performance nanofibrous membranes.
Objectives	One of the key advantages of electrospinning is the broad versatility of polymer systems that can be processed and the precise control over the resulting fiber morphology, which can be tailored to meet the requirements of specific applications. To enhance the sustainability of nanofiber production, water-based formulations are increasingly favored, as they eliminate the need for toxic organic solvents. However, the use of aqueous systems introduces challenges: polymer solubility in water and potential morphology loss can compromise the structural integrity and long-term stability of electrospun membranes. To address these limitations, chemical crosslinking (particularly photo-induced crosslinking using a light of suitable wavelength) has emerged as an effective strategy to stabilize the fiber network. This approach improves thermal, mechanical, and solvent resistance while preserving the desirable functional characteristics of the material. This PhD project focuses on the electrospinning and photo-induced crosslinking of water-based polymer solutions or dispersions as a sustainable pathway to produce stable, environmentally friendly nanofibrous membranes. By systematically optimizing electrospinning parameters and evaluating the resulting structural, mechanical, and functional properties, the project aims to develop advanced nanostructured polymeric materials with

	potential applications in packaging, wound healing, and biosensing. Further functionalization will be explored to tailor membrane performance for targeted uses, including the incorporation of fillers such as cellulose nano- and microfibrils, or active additives. For example, embedding cyclodextrins will enable controlled release of specific molecules, opening opportunities in biomedical devices, active food packaging, and other high-value applications.

Skills and competencies for the development of the activity	The PhD candidate should preferably have a background in Materials Engineering, Materials Science, or Chemistry, with solid experience in polymer processing and characterization. Prior experience with electrospinning is highly appreciated. Strong proficiency in English is required. The candidate is expected to demonstrate a hands-on approach to laboratory work, strong problem-solving skills, high motivation for learning and advancing through research, and the ability to adapt to multidisciplinary and dynamic environments.