# PhD in Materials Science and Technology

# Research Title: NANOSTRUCTURED MATERIALS FOR DRUG DELIVERY AND WOUND HEALING

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| **Funded by** | Politecnico di Torino |

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| **Context of the research activity** | In the last years, the healthcare field has been revolutionized by the development of innovative technological strategies, involving the design, fabrication and application of nanostructured and nanoporous drug carriers. In this context, the development of materials-based products and their therapeutic applications in dermatology has become a growing research area. New technological approaches in the production of nanomaterials-based medicines can radically change the current skin treatments, for instance delivering a wide range of beneficial molecules to skin or acting as drug carriers. The application of innovative topical drug carriers has been attracting much attention to improve the administration of topical antimicrobials. The need of topical antimicrobial treatment is crucial in the wound healing. Wound healing is a complex, specific, biological process that involves the interactions between cells, extracellular matrix (ECM) components, and signaling compounds.<br>In the context of innovative drug carriers, the loading of the drug through green techniques is required. Particularly, supercritical $CO_2$ (scCO2) technology is an alternative to conventional drug loading techniques, such as the adsorption or impregnation from an organic solvent solution. This technology is considered a green drug impregnation method since $scCO_2$ is readily available, cheap, non-flammable and recyclable, which make it an environmentally-friendly approach. Moreover, $scCO_2$ is not toxic, thus it is particularly suitable for the processing of pharmaceuticals. $ScCO_2$ is a good solvent for poorly-water soluble drugs. This represents an |

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| | outstanding advantage, due to the possibility to replace the use of organic solvents in the processing of poorly water-soluble molecules. Eventually, it is known that $scCO_2$ permits a better drug molecules-material interaction to be obtained, so that the loaded drug is in amorphous state, which accelerates its dissolution profile and, consequently, its bioavailability. |

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| **Objectives** | The project aims at developing new nanostructured and nanoporous drug carriers for topical administration, with particular attention to the wound healing.<br>The materials are based on nanoporous silica and nanostructured zinc oxide. In addition, composite materials for wound dressing will be developed, using biocompatible and biodegradable polymers, able to support the cell growth and to release drug in a controlled way.<br>The research activity will start from the synthesis of the materials and their physico-chemical characterization.<br>In a second step, the drug-loading through adsorption, impregnation and $scCO_2$ will be carried out.<br>In particular, the research will focus on antimicrobial agents and vitamin K.<br>The development of new medical devices able to control external hemorrhage after traumatic event, in persons with coagulation disorders or in persons who administer anti-coagulant drugs is very important to increase survival and prevent complications due to blood lost. One of the aims of the project is the design of new topical devices, based on nanoporous materials loaded with anti-hemorrhagic agents, such as vitamin K or tranexamic acid, able to improve hemostasis process.<br>The drug delivery properties will be investigated by means of different methods, including those based on the Franz cell.<br>The biocompatibility and the biological activity of the nanostructured carriers will be also studied. |

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| **Skills and competencies for the development of the activity** | Skill and competences in biomaterials, biomedical engineering and material science and engineering are required.<br>The research activity will be organized and carried out as a team work, in collaboration with one post-doc researcher and several master students. For this reason, the ability to work in a team and to interact and collaborate with other researcher is strongly required. |