Process-Integrated Functionalization of 3D Meltblown Structures for Wound Healing Applications

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Abstract

Growing concerns about the environmental impact of petroleum-based plastics have intensified the search for sustainable alternatives. In the medical field in particular, a wide range of disposable products are used, many of which are manufactured from petrochemical-based plastics. The development of more sustainable materials for these applications is therefore of increasing importance.
In this context, polyhydroxyalkanoates (PHAs) have attracted considerable attention as promising sustainable alternatives. PHAs are a class of biobased polymers that can be produced through biosynthesis using genetically modified plants, natural isolates, recombinant bacteria, or certain algae. The resulting polymers are biobased and biodegradable, including under marine conditions, making them particularly attractive for applications where reducing the environmental impact of disposable medical products is a key objective.

The aim of this research project is to develop a sustainable, three-dimensionally adapted wound dressing based on poly(3-hydroxybutyrate) (PHB) using the meltblown process. The project will focus on the development of suitable nonwoven structures, their adaptation to the requirements of wound care, and the integration of a novel active ingredient delivery approach.

As a first step, a 3D conveyor belt will be designed and developed in collaboration with Siebfabrik Arthur Maurer GmbH & Co. KG. The conveyor belt will be specifically adapted to the production and processing of the novel nonwoven materials and will enable the fabrication of three-dimensionally shaped structures. In parallel, nonwoven fabrics based on different PHA types will be developed. Key structural parameters, particularly fibre diameter and basis weight, will be systematically varied. Their influence on porosity as well as liquid and air permeability will be investigated in order to identify and tailor suitable nonwoven structures according to the defined requirements.
In addition, a spray device for the novel application of active ingredients will be developed and integrated into the manufacturing process. The resulting PHB nonwovens will subsequently undergo comprehensive physical and chemical characterisation to determine their relevant material and structural properties. Finally, the loading of the nonwoven fabrics with a model active ingredient will be investigated to assess the suitability of the developed nonwoven structures and the novel application method for active ingredient incorporation.

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