Reproducible Hot Embossing Process for the Realization of Functional Parylene Micro Structures Medical Wearables

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Abstract

The objective of this research is to refine the fabrication process of Parylene C microstructures, intended for implementation in medical wearables. These smart plaster-like devices necessitate an enduring, biocompatible skin attachment, free from the adverse skin reactions induced by conventional chemical adhesives. The proposed solution is inspired by gecko adhesion structures and involves the realization of functional hierarchical micro and nano structures by means of generating significant contact forces without the use of chemical adhesives.

This research continues prior work, examining the reproducibility and improvement of the sidewall quality of Parylene C microstructures, fabricated through a hot embossing process. The process parameters, including embossing temperatures, embossing forces, demolding temperatures, and demolding speeds, were varied under vacuum conditions, reducing risks of degeneration or oxidation of Parylene. Microstructural characterizations were conducted using profilometry, confocal measurements, and Scanning Electron Microscopy (SEM). Material analysis further ascertained the impact of hot embossing on the properties of Parylene C.

This study confirms the reproducibility and the enhanced quality of Parylene C pillar microstructures (10 µm heights, 20 µm diameters, and variable pitches of 20 µm, 40 µm, and 80 µm) on chip level, using hot embossing. Good reproducibility was observed at an embossing temperature of 305 °C and a force of 25 kN. Furthermore, demolding at 40 °C at a rate of 0.2 mm/min mitigated delamination and sidewall roughness issues.

In conclusion, optimized hot embossing emerges as an effective method for the reliable and reproducible fabrication of high-quality functional Parylene C microstructures. With subsequent metallization and encapsulation, these structured Parylene C microstructures can be exploited in medical wearables, as well as in other advanced applications such as ultra-thin printed circuit boards, optical waveguides, and microfluidic systems.

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