Dursan's successful integration into a customized mold system

Technical Insight

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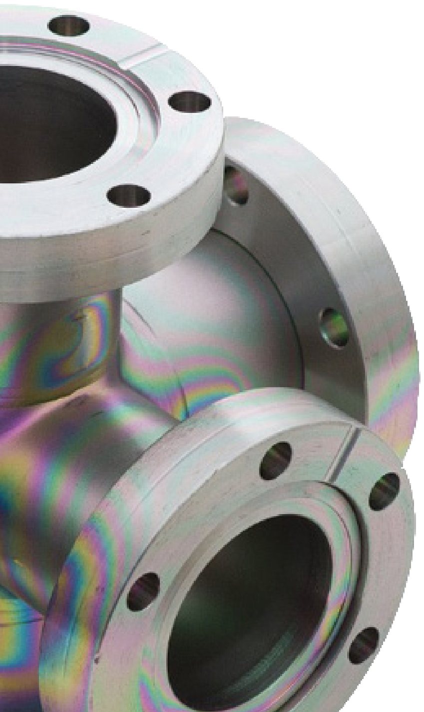

Synopsis

This TI is an executive summary of a recent published conference proceeding titled "UV-imprint of micro-textured polymer films for biomedical disposables". The authors custom designed an injection mold system to fabricate structured polyacrylate films using a UV imprinting process. Dursan coating applied to the inserts of the molding tool helped to reduce demolding defects in the polyacrylate films to a minimum.

Background

This TI is an executive summary of a proceeding from euspen's 22nd International Conference & Exhibition held in Geneva in May and June of 2022. Link to the full paper can be found here.

The aim of this paper was to develop a mass-production capable and cost-effective manufacturing process for polymer films with multifunctional surfaces. Such films are in growing demands in the life science sector, as they find use in various biomedical applications, such as disposable biomedical sensors used in blood analysis, where both hydrophilic and hydrophobic properties are required on different areas of the microfluidic chips. A big challenge faced by many companies making these polymer products is the constant need to integrate new production technologies into their manufacturing process to accommodate the increasingly complex product functions required, while maintaining cost and efficient timelines. Motivated to meet this challenge, the authors set out to design a customized mold system using UV injection molding, as this technique not only offers reduced cycle time but also allows for greater flexibility in adjusting the resulting polymer films' mechanical and chemical properties, reducing the need of having to integrate multiple technologies to deliver different properties.

Data and Discussion

The two most common techniques currently used in the production of microfluidic films are hot embossing and injection molding. Hot embossing requires heating the polymer precursor above its glass transition temperature and subsequent cooling for demolding, which translates to a long cycle time of at least 10 minutes. Conventional injection molding also requires melting of the thermoplastic material and cooling for demolding, but also presents limitations in miniaturization and surface modification. In comparison, an emerging technique known as UV injection molding has garnered increasing attention due to its shorter cycle times and better flexibility. This technique uses a liquid resin at room temperature, which turns into a solid polymer within seconds upon exposure to UV radiation of a certain wavelength. The ability to work under ambient conditions (eliminating heating or cooling) reduces the cycle time by up to 50% and the properties of the resulting polymer product can be adjusted by adding suitable additives to the starting resin, adding much desired flexibility to this process.

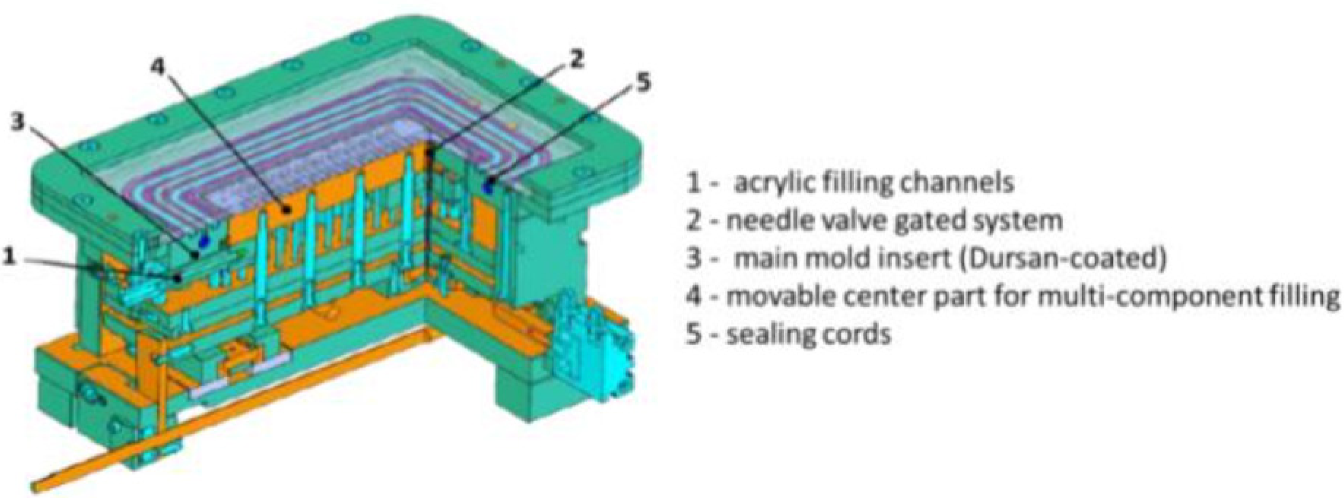

Figure 1: The custom-designed UV imprint mold system developed by the authors of this paper

Figure 1 shows an illustration of the custom-designed UV injection mold system developed by the authors of this paper, which they use to fabricate structured polyacrylate films that have potential to be used for biomedical disposables. The mold was constructed with tool steel with a float glass slide on top, and when initially used without any coating, a significant number of defects were observed on the produced polymer due to sticking of the acrylate during demolding. After evaluating different surface coatings, Dursan was selected based on its superior performance. According to another paper from the same authors, Dursan's "inert, wear- and corrosion-resistant" properties in combination with "a high hydrophobicity" and the ability to be applied to both steel and glass components of the tool system, solidified its position as the coating of choice. The authors commented that "the SEM images of the produced polymer films and of the coated tools showed a significantly more homogeneous and smoother surface", as well as "better water contact angles" for Dursan in comparison to competing coatings during evaluation.

The polyacrylate foils produced with the Dursan-coated custom mold exhibited a high quality of the microstructures and good reproducibility for a small series of replicates. Demolding defects in the polyacrylate foils were reduced to a minimum due to the Dursan coating. The authors were able to optimize the properties of the polyacrylate films, such as transparency, mechanical stiffness, low autofluorescence and biocompatibility, with respect to their future applications. Their work demonstrated the potential of the polyacrylate film to be used in plastic microfluidic chips for cell-based assays and biosensor disposables.

Summary

This TI is an executive summary of a proceeding from euspen's 2022 conference. The authors demonstrated successful fabrication of structured polyacrylate films using a custom-designed UV injection mold system. SilcoTek's Dursan coating applied to the mold inserts significantly reduced demolding defects in the resulting polymer products. The optimized polyacrylate film showed potential to be implemented in plastic microfluidic chips for cell-based assays and biosensor disposables.