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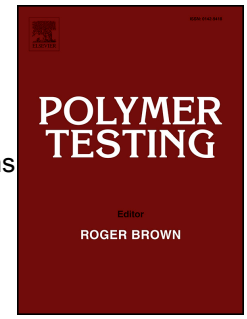

Development of an embossing process for micro-scale patterns of polypropylene films using statistical design of experiments (DoE) – A strategy to reduce the number of freedom in process settings to find the optimum

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Development of an embossing process for micro-scale patterns of polypropylene films using statistical design of experiments (DoE) – a strategy to reduce the number of freedom in process settings to find the optimum

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Abstract

An imprinting process with a brass stamp is used to generate a step on polypropylene plates. Process parameters are systematically varied, temperature, pressing-time, -pressure and the resulting step-heights are determined. Combining the direct correlation of step-height with its variation as a function of process parameters reveals most desirable process parameters. The approach described can be applied to a wide range of processing challenges.

Keywords: imprinting, embossing, polypropylene, microscale pattern, optimization strategy

INTRODUCTION

Structured polymer-surfaces in the 10 µm regime are having their predominant application in self-cleaning properties. Therefore various approaches such as laser-structuring can be considered. Imprinting techniques are gaining importance in improving reproducibility and optimizing manufacturing costs.[1] They have also been successfully investigated with regard to increasing the surface area and adhesive strengths of samples by mechanical interlocking.[2] In the present case the challenge was to produce a discrete step of particular height to investigate the sensitivity of the tongue. Therefore the material used has to fulfill medical requirements, especially with respect to germ-killing and being easy to clean. It is well documented that the economical material polypropylene can easily be processed by imprinting[1,2] and can comply with medical standards.[3,4]

EXPERIMENTAL

Samples

As described above, the material should be easy to process via pressing, exhibit high chemical and water resistance, be sterilisable, contain no harmful ingredients and be easy to obtain. Therefore the polypropylene “100-GA03” from Ineos was chosen as it fulfills all these requirements.

Table 1: Manufacturer’s information regarding Ineos HPP 100-GA03

Property	Value	Test method
Melt Flow Rate (MFR)	3 g/10 min	ISO 1133
Flexural Modulus @23 °C	1450 MPa	ISO 178
Tensile strength	35 MPa	ISO 527-1,-2
Notched Izod Impact Strength @23 °C	4 kJ/m²	ISO 180/1A
Melting Point	163 °C	ASTM D 3417
Vicat Softening Temperature @10 N	156 °C	ISO 306/A
Heat Deflection Temperature @0.45 MPa	93 °C	ISO 75/B