Chemical stability of ultraviolet-ozone treated, injection-moulded poly lactic acid micro-cantilevers

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INTRODUCTION: Polymers including poly lactic acid (PLA) are widely used in the area of bio-analytics and bio-sensing. Micro injection moulding (µIM) belongs to the promising methods for mass fabrication of polymeric biosensors, such as micro-cantilevers (µCs) [1]. Injection moulded µCs have been successfully applied for sensing bio-molecular interactions [2]. Clean surfaces are a pre-requisite for sensing interactions. Ultra-violet ozone (UVO) treatment, which is used as a standard procedure for cleaning, may degrade the polymer material and hence needs to be studied.

METHODS: PLA µCs were manufactured using µIM as described earlier [1]. The surface of the PLA µCs was treated in the UVO cleaner (UV Clean Model 13550, Boekel Scientific, Feasterville PA). The PLA µCs were treated for a period of 30 minutes. Changes to the material's surface were investigated by reflection Fourier transform infrared spectroscopy (FT-IR). FT-IR spectra of two areas of the cantilever holders were performed using a Centaurus IR-microscope coupled to a Nexus IR spectrometer (Thermo Electron, Thermo Fisher Scientific, Dreieich, Germany) with a grid of 300 µm × 300 µm. The material was examined for changes using a Differential Scanning Calorimeter (DSC). The entire µC array along with the holder was thermally analyzed with DSC (DSCQ1000, TA Instruments, Waters GmbH, Eschborn, Germany). The recordings consisted of a first heating cycle from 0 to 250 °C, subsequent cooling to 0 °C and a second heating cycle again to 250 °C, in dry nitrogen atmosphere.

RESULTS: The FT-IR spectra of starting status and of 30 minutes UVO-exposed PLA specimens were almost identical. However, a slight decrease in the intensity of the ester signals (1250 to 1050 cm^{-1}) after irradiation was observed. The DSC recordings allowed the evaluation of the glass transition temperature (T_g) during the cooling phase and the second heating phase. A significant reduction in T_g by about 4 K was found indicating a chemical aging of the PLA specimen.

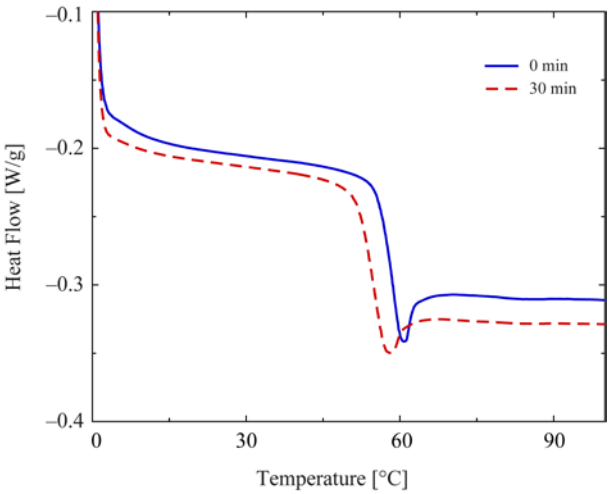

Fig. 1: The DSC analysis shows a significant decrease of the glass transition temperature after 30 minutes of ultraviolet-ozone exposure.

DISCUSSION & CONCLUSIONS: UVO-treatment as a surface cleaning method can significantly influence the properties of PLA µCs. We observed chemical aging after 30 minutes UVO-exposure [3].

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