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Publication date:
2015

Document Version
Peer reviewed version

Effect of Functional Nano Channel Structures Different Widths on Injection Molding and Compression Molding Replication Capabilities

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Abstract. The present study investigates the capabilities of the two employed processes, injection molding (IM) and injection compression molding (ICM) on replicating different channel cross sections. Statistical design of experiment was adopted to optimize replication quality of produced polymer parts with the two different molding technologies. Focus of the experimental work was the assessment of the IM and ICM processes capabilities to replicate different channels widths (240 nm, 440 nm and 1040 nm) at different positions from the gate based on the deviations of their dimensions from the corresponding geometries measured in the nickel master. Results presented as main effect plot of channel depth deviation from ideal nickel master and polymer replicated features are reported.

Keywords: Injection molding, Lab-on-a-chip, nano metrology.
PACS: orcid.org/0000-0002-9437-9829

MODLING EXPERIMENTS

Functional structures are represented by nano channels gratings manufactured perpendicularly to main carrier micro channels, aimed at transporting molecular solutions with DNA chains [1]. Based on the optimization results from the experimental injection molding campaign an additional design of experiment (DOE) was run for the compression molding experiments testing effects of different compression gap and switch over point levels. The output of analysis result was based on ISO 5436 [2] step height measurements performed using a calibrated atomic force microscope [3].

RESULTS

Effects of the different settings levels within the optimal processes windows produced maximum channels height variation of maximum 7 nm from original nickel dimension. The maximum variation was quantified for nominal channels width of 240 nm produced by injection molding. Pitch distance of 5 µm for the produced functional channels gratings enabled the polymer to flow in between trances resulting in nanometer range (± 5 nm) product replication fidelity. Inside this tolerance range the quantified replication quality observed for the different channels width molded at different process conditions was independent by the adopted process.

ACKNOWLEDGMENTS

The present research was carried out within the National Danish Strategic Research Centre PolyNano (http://www.polynano.org/) supported by the Danish Council for Strategic Research (DSF grant no. 10-092322). The collaboration of the Danish Metrology Institute (DFM) and the Scanning Probe Microscopy Group is greatly acknowledged.

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