Metrology of sub-micron structured polymer surfaces

Quagliotti, Danilo; Tosello, Guido; Salaga, J.; Baruffi, Federico; Hansen, Hans Nørgaard; Gasparin, Stefania

Publication date:
2016

Document Version
Peer reviewed version

Metrology of sub-micro structured polymer surfaces

D. Quagliotti[1], G. Tosello[1], J. Salaga[1], F. Baruffi[1,3], H. N. Hansen[1], S. Gasparin[2]

[1] Technical University of Denmark, Department of Mechanical Engineering, Kgs. Lyngby, Denmark
[2] The LEGO Group, Billund, Denmark
[3] Politecnico di Milano, Dipartimento di Ingegneria Meccanica, Milano, Italy

Precision moulding is an essential technology for the miniaturisation of moulded parts and it is continuously needing for specially developed solutions to face new challenges in injection moulding (IM) processes.

One of the key challenges in advanced IM technology is the achievement of a full surface replication of the tool insert component when moulding the polymer melt [1]. This aspect is particularly critical when dealing with increasingly small dimensional scales in micro- and nano-structured surfaces [2, 3].

In this context, a metrological investigation of polymer replicated surfaces using metal masters with different types of finish has been carried out.

Four types of surface finish were considered: a) Diamond buff polishing. b) Grit paper polishing. c) Stone polishing. d) Dry blast polishing (see Fig. 1). Both master and replicated surfaces were measured using a laser scanning confocal microscope. Hence, the replication fidelity was evaluated comparing the measurements of the polymer surfaces against the ones of the masters. The amplitude and the slope replications were considered calculating respectively *Sq* and *Sdq* areal surface texture parameters. The expanded uncertainty was also evaluated according to ISO 15530-3:2011, adapted to optical measurements, and propagated to the replication fidelity.

A good amplitude replication was achieved for stone polished surfaces with a replication fidelity larger than 90 %. The dry blast ones were evaluated with an amplitude replication fidelity of about 70 %. The worst amplitude replication was achieved for both diamond buff and grit paper polished surfaces with a replication fidelity around 50 %.

The tendency is almost the same for slope replication but the replication fidelity values are lower: 70 % for stone polished surfaces. 50 % for dry blast and grit paper polished surfaces. 30 % for diamond buff polished surfaces.

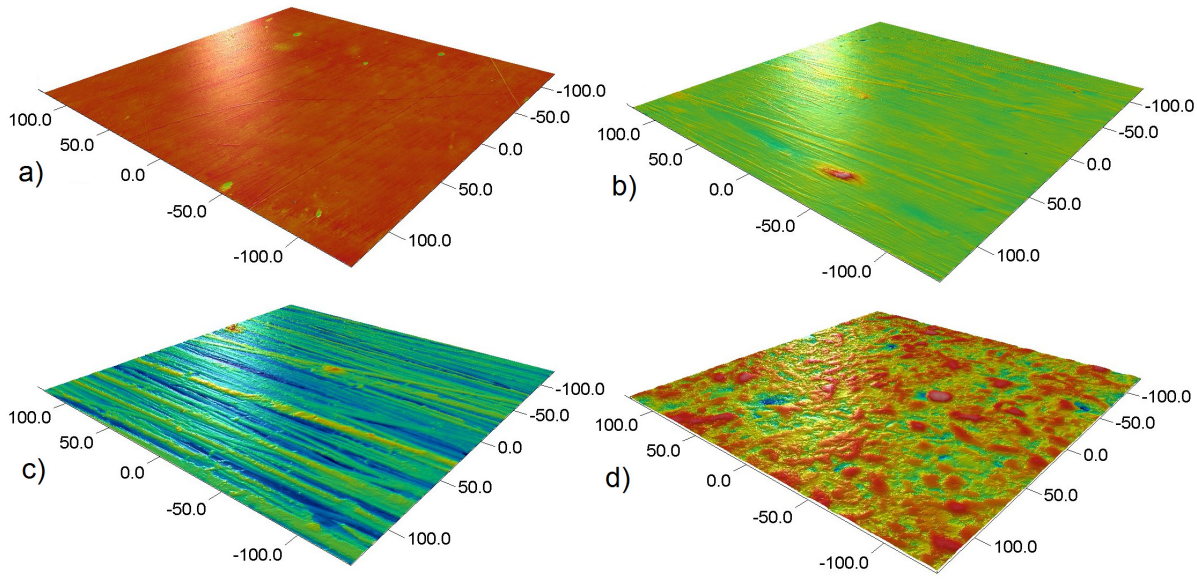

Figure 1: Examples of replicated surfaces using different surface finish of the masters. a): Diamond buff polishing. b): Grit paper polishing. c): Stone polishing. d): Dry blast polishing.

References

1 H. N. Hansen, R. J. Hocken, G. Tosello *CIRP Ann. - Manuf. Technol.* **60** 695–714 (2011).
2 G. Tosello, H. N. Hansen, S. Gasparin *CIRP Ann. - Manuf. Technol.* **58** 467–72 (2009).
3 G. Tosello, F. Marinello, H. N. Hansen *Rubber and Composites: Macromolecular Engineering* **41**-1 29-39 (2012).