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Structural "decoration" of plastic products replicated from nanoimprinted steel inserts

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Abstract

Structural colouration is a well-known "bio-inspired" phenomenon that explains the astonishing natural iridescence of several animals' skin, such as: fish scales, birds' feathers, butterflies' wings, flowers and more beauties in nature. The phenomenon occurs when light diffracts due to the topology of the just mentioned surfaces independently from radiation-based colouring or pigmentation. In recent years, the rise of nanotechnology has brought about the possibility to design and reproduce structural colours on consumer products [1]. In this study, structural colours are proposed as decorative features for plastic substrates. Periodic sub-micro gratings showing a variable pitch (400 – 1500 nm) and step height (300 – 1000 nm) are manufactured in a cleanroom by means of nanoimprinting lithography on steel inserts. Gratings are subsequently replicated on plastic products by means of polymer injection moulding. This study focuses on understanding the technology readiness, highlighting limitations and advantages of the adoption of structural colours in plastic consumer products. Aspects related to different polymer replication techniques of the nanostructures, metrological challenges to ensure manufacturing accuracy and precision of the mentioned features, the durability of the plastic gratings and the durability of the nanoimprinted injection moulding inserts would be key factors in understanding the applicability of structural decoration in the plastic industry.

Structural colours, Plastic decoration, Nano texturing, Nano Imprint Lithography, Injection Molding, Nano Tolerances, Multiscale metrology

Process chain enabling the production of structural "decorated" plastic goods

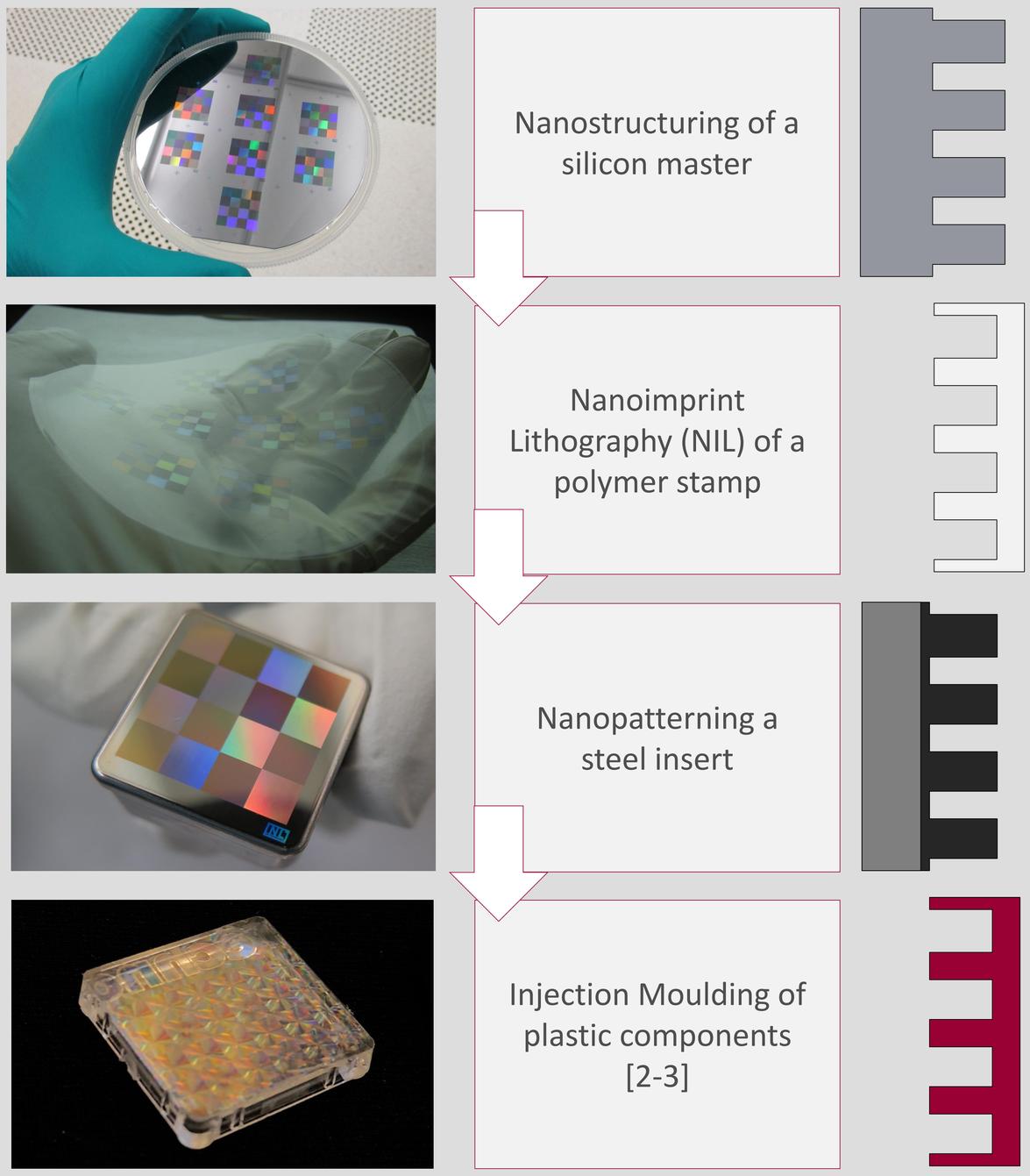

Fig. 1: Process chain for the production of structural decorated plastic components

Challenges and Technology readiness

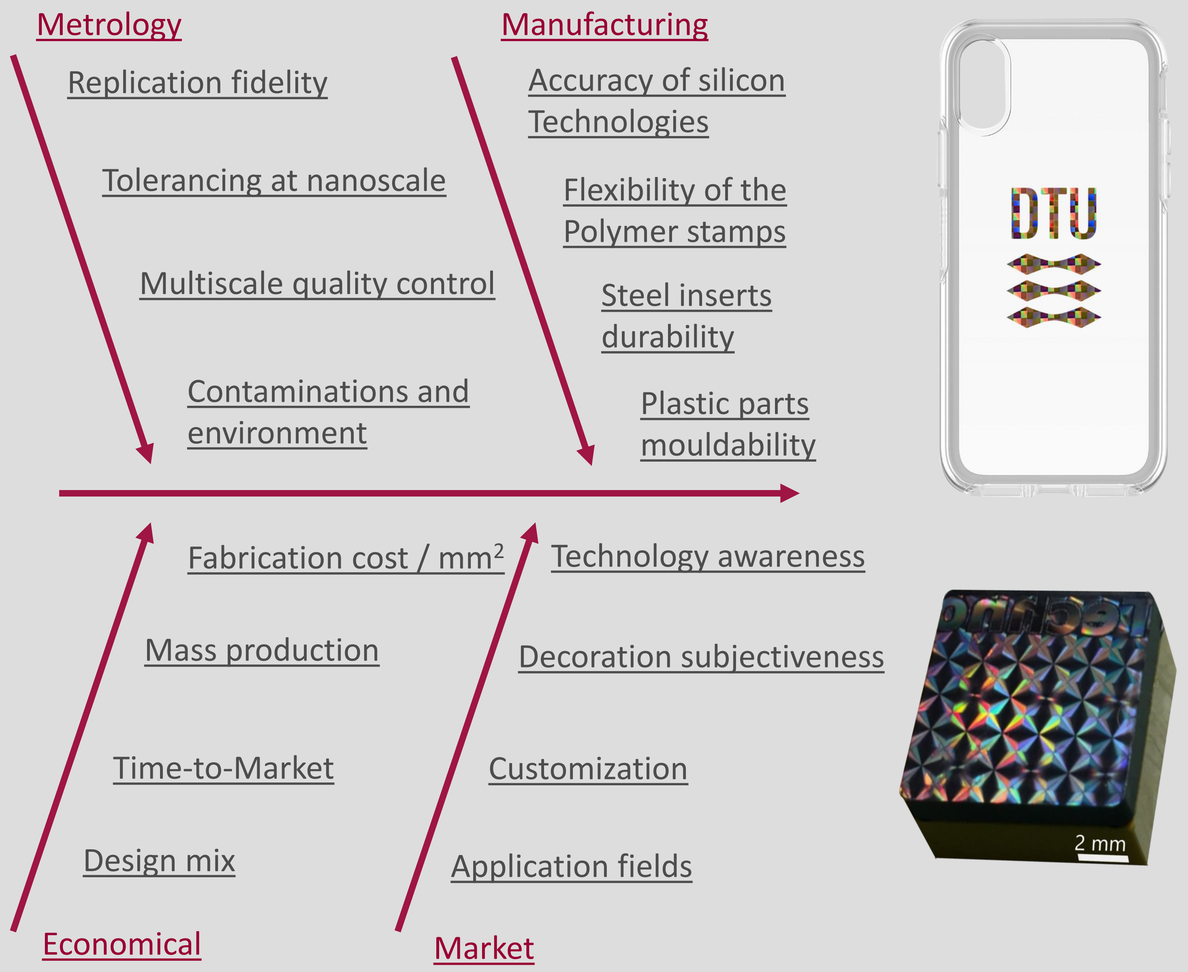

Fig. 2: Analysis of the different technology and economical enabler

Replication fidelity

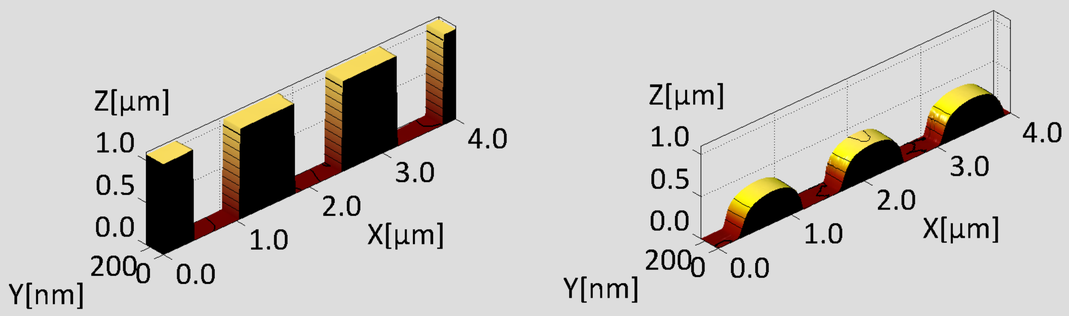

Fig. 3: Replication fidelity [4-5] from master geometry (left) and plastic part (right)

Multiscale complexity and accuracy

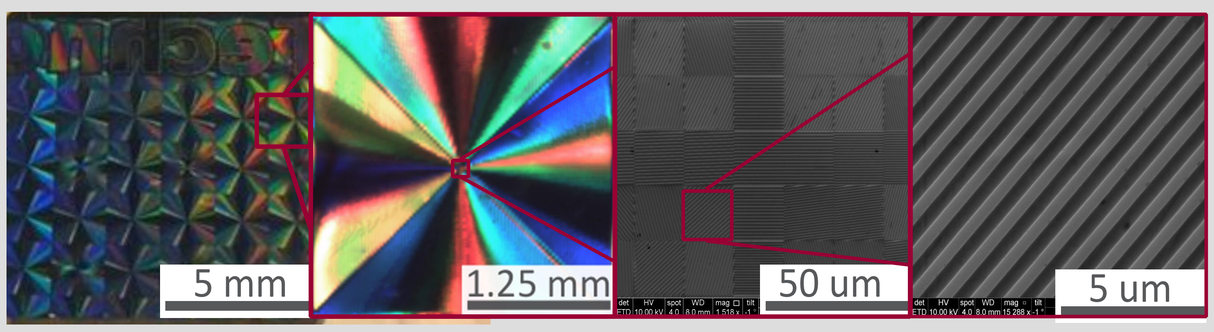

Fig. 4: Multiscale investigation from product decoration effect to nano grating

Conclusion

Structural "decoration" of plastic components through nano texturing is a successful example of how nano technology is brought to consumer products. Most of the economical and technological enabler for this to come true have been summarized in this poster. The specification of nanoscale tolerances for the replication fidelity of the grating structures are paramount in the effective replication of the decoration effect on the plastic component. The combined accuracy of silicon technologies replicated on mass production with injection moulding ensure a cost effective solution for tackle potential markets.

Acknowledgements

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