Manufacturing of High-added Value Micro-nanostructured Plastic Components

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We report on the latest developments of the Interreg project PIMENT. The main goal of this project is to combine state-of-the-art metal micro- and nanostructuring techniques with injection molding for the fabrication of functional plastic components. A first phase was dedicated to the development of metal micro and nanostructuring techniques with the challenge of processing both planar and non-planar surfaces. The second phase focused on the production of micro-nanostructured plastic parts by means of injection molding. Micro and nanostructures were designed for two case studies: a bio-diagnostic platform and for decorative effects.

The main objective of the project PIMENT is to foster innovation in the field of micro-manufacturing and injection molding. This transnational Interreg project gathers specialists from French and Swiss companies and research centers with the goal of producing high-added value micro-nanostructured plastic parts by injection molding. There is indeed a growing trend to develop more advanced processes for the fabrication of functional products by means of injection molding. The high throughput of this technique and the recent breakthroughs in terms of replication accuracy have made it a standard for the production of nanostructured parts and devices such as optical data storage media and holographic structures four anti-counterfeiting. Beyond these examples, surface micro/nanostructuring has real potential to control additional surface properties such as adhesion, wetting, biological-matter interactions.

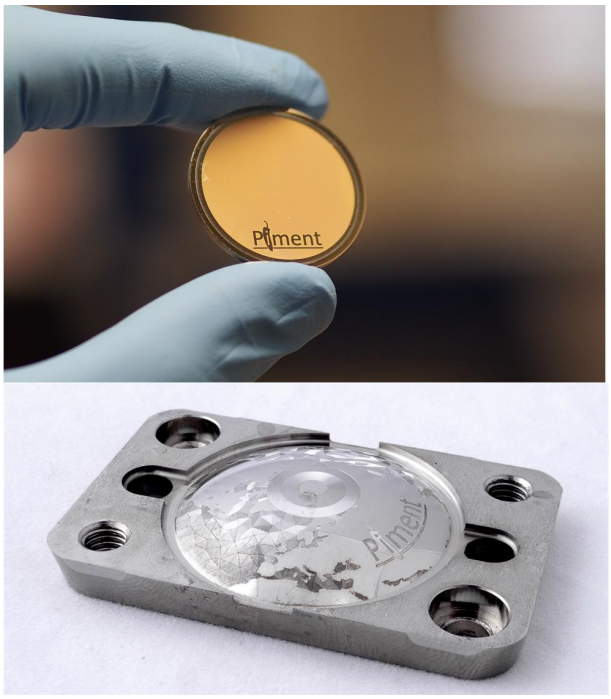

Figure 1: Photographs of a nanostructured stainless steel coin (top) and a microstructured mold steel (1.2343) insert (bottom), both fabricated during the project.

Well-established tooling techniques such as electroforming are currently used to produce micro/nanostructured mold inserts. However, there have been problems of integration into injection molds, especially when non-planar parts must be produced.

One of the key challenges addressed during the project PIMENT is the development of a new process chain for the fabrication of micro/nanostructures on planar and non-planar steel mold inserts.

Three types of inserts (flat, curved and micro-structured) have been used for two final applications: a bio-diagnostics platform and a watch glass. On the first demonstrator, the goal was to integrate micro/nanostructures on the detection spots of the bio-diagnostics platform to increase its sensitivity. The structures were fabricated on detection spots located in a microfluidic channel. For the second demonstrator, a curved insert was fabricated and surface microstructures were integrated for decorative purposes. The microstructures were designed to induce a change in pattern upon rotation and tilt. Figure 1 presents photographs of two micro and nanostructured steel inserts made during the project.

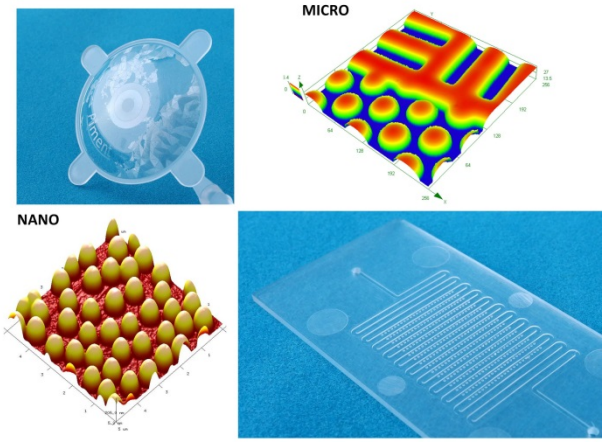

Figure 2: (top) Photograph and interference microscopy image of a micro-structured plastic replica produced by injection molding; (bottom) Scanning electron microscope image and photograph of nanostructured samples made for the bio-diagnostics platform.

For the fabrication of plastic replica, hot embossing and injection molding have been used. In Figure 2, photographs, atomic force microscopy and interference microscopy images of plastic replica produced during the project are presented.

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