

Innovative laser manufacturing processes at nano scale within the NewSkin Open Innovation Test Bed

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ABSTRACT

Laser nanotechnologies have enormous potential for bringing products with new surface functionalities to market, while meeting sustainable development objectives. However, SMEs and start-ups are not benefiting fully from these technologies because of their cost and the necessary access to testing and validation infrastructures. The Horizon 2020-funded NewSkin project has thus created an Open Innovation Test Bed (OITB) focused on surface nanotechnologies to overcome these challenges. It provides access to scale-up and testing facilities to enhance surface properties in different relevant sectors. Regarding laser nanotechnologies, NewSkin provides access to different laser up-scaling facilities that integrate innovative manufacturing processes, including surface texturing, roll-to-roll femtosecond laser texturing, heat-treatment laser, multi-modal laser processing. Several companies and research organisations have benefited from these technologies to improve surface functionalities such as wettability properties, improved heat exchange, friction reduction, wear resistance. The creation of NewSkin AISBL will further accelerate the uptake of innovative laser processes to manufacture new nano-enabled products.

Keywords: laser nanotechnology, laser manufacturing process, surface texturing, nanosurface, functionalisation, OITB

1. INTRODUCTION

NewSkin is an OITB, a new legal entity that provides access to physical facilities and services for the development, validation, and commercialisation of new nano-enhanced products. This Horizon 2020-funded project is coordinated by the European Convention for Constructional Steelwork and comprises 34 partners from 12 European countries¹. The partners are universities, research and technology organisations, associations, clusters, and private companies, contributing to the quintuple innovation helix. Within the NewSkin service portfolio, laser nanotechnologies are available to enable companies to adopt innovative laser processes for the manufacture of nanotechnology products.

2. METHODOLOGY

Laser texturing has numerous advantages. It can improve the properties of different surfaces. For example, ultrafast laser texturing is a process enabling to give anti-fouling properties². Additionally, laser texturing is a relevant technique for many sectors as it can be applied to various materials and does not require the use of toxic chemicals. This is why NewSkin OITB has included access to laser facilities in its portfolio of services. NewSkin has provided free access to laser up-scaling facilities to increase the TRL of a wide range of products (from TRL4 to TRL7) through four competitive open calls. The laser facilities used in the NewSkin framework (Table 1) are provided by AIMEN, ALPhANOV and the Dublin City University (DCU). Each facility has its own specifications and integrates different technologies such as Laser-Induced Periodic Surface Structures (LIPSS), Direct Laser Interference Patterning (DLIP), Optical Wavefront Shaping (OWS). Various parameters can be adjusted for each facility, allowing to produce a wide range of structures. These three RTOs provide different services: design and evaluation of functional textures, surface micro and nano-structuring of pieces, testing and characterization services, laser hardening and texturing. These services enable SMEs and start-ups to adopt innovative processes for the manufacture of nanotechnology products.

Table 1. Description of the NewSkin laser up-scaling facilities

	Description of the laser facility	Functionality	Use
AIMEN	<p><i>Laser up-scaling facility</i></p> <p>Laser type: Ultrafast laser sources in IR, vis and UV</p> <p>Sample dimensions: Tool up to 0.5m².</p> <p>Substrates: Metallic, carbon-based, ceramic</p> <p>LIPSS and OWS</p> <p>Process: Batch</p>	<p>Hydrophobic</p> <p>Anti-fouling</p> <p>Anti-bacterial</p> <p>Reduced friction and wear</p> <p>Improved heat exchange</p>	<p>Roll to roll cylinders, moulds, filtration, medical devices, electronics, optical, tribological, membranes</p>
ALPhANOV	<p><i>Roll to Roll Laser Machine</i></p> <p>Laser type: 350 W, IR, Femtosecond</p> <p>Sample dimensions: Few hundreds of microns thick coils, 50 m length, width 40 cm.</p> <p>Substrates: Metal foils and other flexible materials</p> <p>LIPSS and DLIP</p> <p>Process in line monitoring: Yes, scatterometry</p> <p>Process: Roll to Roll, continuous</p>	<p>Anti-bacterial</p> <p>Superhydrophobic</p> <p>Anti-icing</p> <p>Anti-fouling</p> <p>Self-cleaning</p>	<p>Can and coil coatings, metal foils and coils, food packaging, superhydrophobic surfaces</p>
DCU	<p><i>Multimodal laser texturing and heat treatment set-up</i></p> <p>Laser type: Femtosecond laser (>370 fs) with a central wavelength of 1030 nm used for ultrafast laser texturing, a 1 kW CW fiber laser used for surface heat treatment with a central wavelength of 1070 nm.</p> <p>Substrates: Metallic, ceramic, polymeric, glass, a 5-axis stage for mounting flat and cylindrical workpieces</p> <p>LIPSS and OWS</p> <p>Process: Batch, continuous</p>	<p>Anti-icing</p> <p>Anti-fouling</p> <p>Reduced friction and wear</p> <p>Nano-pores creation on membranes</p>	<p>Texturing of complex geometries (propellers, pistons, gears, shafts, pinions, rock drills, hulls, membranes), laser drilling / perforation of pores</p>

3. RESULTS

The NewSkin OITB has supported 27 demo-case projects for various relevant industries such as aerospace, automotive, energy, marine, steel, enabling the introduction of new surface functionalities in a wide range of industrial materials and components. It has provided access to laser facilities for 11 SMEs/startups, 6 large companies and 4 research organisations to accelerate the industrial uptake of advanced surface nanotechnologies. Giving the growing interest of the NewSkin

services, an international non-profit association has been created, the NewSkin AISBL, to keep providing these services at fair pricing conditions.

4. CONCLUSIONS

The NewSkin OITB has demonstrated that it can enhance the uptake of efficient and cost-effective innovative laser manufacturing processes. With the creation of NewSkin AISBL, the facilities will continue to contribute to the mass production of nanotextured surfaces³ and, subsequently, nanotextured products. To achieve a high level of performance, NewSkin has also designed an interoperable roll-to-roll facility hub, allowing users to combine surface nanostructuring with conformable coatings, such as a combination of laser processes and thermal imprinting or laser processes and High Power Impulse Magnetron Sputtering.

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