Nota Técnica / Technical Note

Femtosecond laser service in 5 axis – MICRORELLEUS S.L.

Resumen: Esta nota técnica de OPA presenta las principales características del láser de femtosegundo y su aplicación industrial con la adaptación de éste en un centro de 5 ejes. Se verán 3 ejemplos de servicios que Microrelleus ofrece para diversas aplicaciones industriales.

Abstract: This OPA technical note presents the main characteristics of the femtosecond laser and its industrial application used in a 5 axis machine. We will explain 3 different examples of services that Microrelleus offers for industrial applications.

The company MICRORELLEUS, S.L.

The company MICRORELLEUS comes from the industrial engraving and micro-milling service for mold and tool, using conventional technologies such as milling machine and die-sinking EDM since 1983.

On 2013 they diversified their service buying the first nanosecond laser machine in 5 axis in Spain, so they began to create texturing and micro-milling with laser.

On 2016 they became world pioneers offering femtosecond laser service in 5 axis. As a result, MICRORELLEUS collaborates with different R&D departments of its customers to help them on the creation of new products based on new manufacturing possibilities and improving efficiency on production.

This services are offered to a wide range industrial sectors, as well as automotive industry, medical device, lighting, electrical appliance, etc.

Femtosecond laser

Femtosecond laser is an ultra-short pulse duration laser.

For controlled surface machining, it is essential to be able to manage the amount of energy delivered. A very fast, high power level is required to quickly reach vaporization, with a rest time to allow the material to dissipate excess of energy.

Using a system to break the laser beam, short pulses are generated to limit the size of the Heat Affected Zone.

The purpose of machining lasers is to minimize energy lost from heating and to maximize the energy used to vaporize the material. By using the ultra-short pulsed laser (a few hundred femtoseconds), it is possible to produce extremely precise machining with no burrs. This is possible due to greater maximum pulse energy and cold ablation machining.

Until 2016 there was not any machine able to integrate femtosecond laser on a 5 axis machine. The Swiss group Georg Fischer was world pioneer creating that machine, so they opened a new range of possibilities in manufacturing processes. From then, it is not anymore a technology limited for investigation or very specific pieces. From now on, there is the possibility to use femtosecond laser on big parts (up to 600x400mm) and over different 3D surfaces.

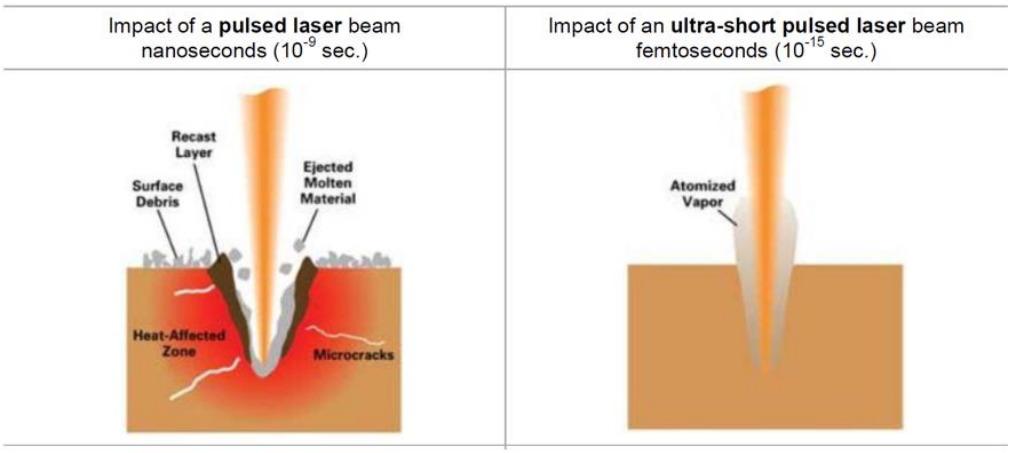

Fig. 1. Comparison of the impact of nanosecond laser vs femtosecond laser

MICRORELLEUS uses the machine to give 3 different services to its customers:

Industrial application 1: functional texturing

Functional texture means adding some functionality because of the micro or nano structure created over the material or over the mold of the plastic part. That functionality can be: superhydrophobicity, superhydrophillicity, antibacterial, friction reduction, light diffraction, etc.

There are a huge number of possibilities using nanotechnology processes, like E-Beam lithography, but those methods are very expensive and very limited in terms of size and shapes of the part.

Using the femtosecond laser machine in 5 axis let Microrelleus add some of those functionalities over big parts (up to 600x400mm) and over a very different range of 3D surfaces.

In terms of size there is a big gap between conventional industrial processes and nanotechnology. Femtosecond laser fits in that "size niche". So there is a huge improvement on industrial application, despite there are not so many possibilities as nanotechnology processes.

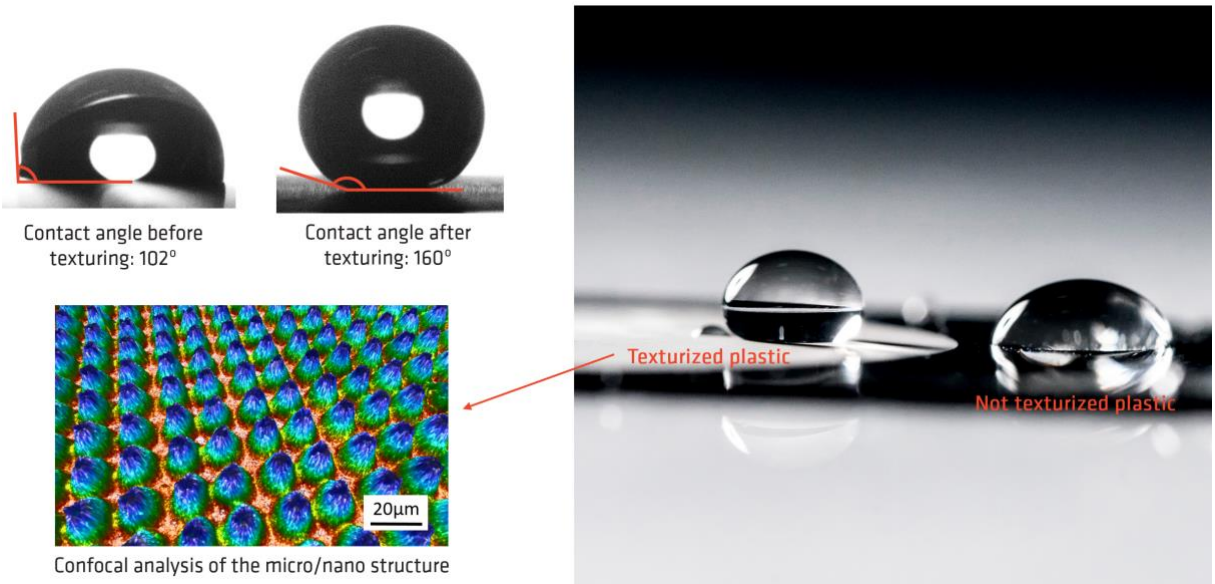

Fig. 2. Analysis of water drop over texturized and not texturized plastic (microstructure applied on mold) and confocal microscope analysis of the micro/nano structure

Industrial application 2: micromilling

For the industrial need of micromilling on mold or tool, companies usually use conventional technologies like die-sinking EDM or milling machines using tool.

There are some limitations using that technologies, mainly in cost, homogeneity and size.

For example, in the case of creating micro-milling over hard metal tool, conventional process means electrode and die-sinking EDM. Most important problems are:

1) Cost: electrode needs to be created using very expensive and small tool. Milling times are high and usually there is the need to create more than one electrode for the die-sinking EDM process.
2) Homogeneity: there is waist both on the tools and the electrodes that affects homogeneity.
3) Size: smaller sizes and sharp edges sometimes are not possible to create using tool.

Femtosecond laser, as we have seen, let us have a burr-free micro milling, homogeneity (there is no tool waist or electrode waist), very sharp edges and very small controlled details. In addition high quality surface finishing is something also easy to achieve using the technology.

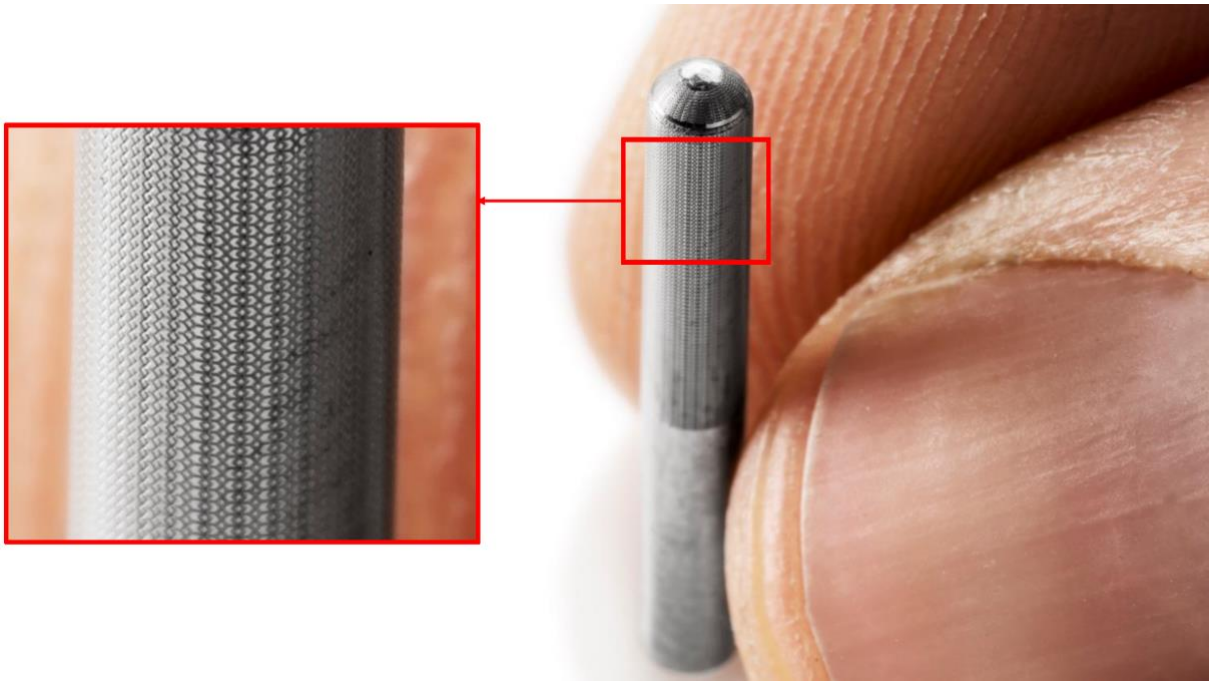

Fig. 3. Micro milling over cylindrical part for medical purposes

Industrial application 3: lighting prototypes texturing

Lighting prototypes are usually created in transparent PMMA plastic. Microrelleus is using femtosecond laser technology for:

1) Light diffusion textures
2) Micro-milling for light guides and light devices

Before existing this technology, there was no possibility for a lot of light prototypes to include both requirements. Especially on controlled and decorative light diffusion and on very small milling over the part.

Microrelleus is able to create any texture and an endless number of micro-milling over PMMA prototypes, as the laser is ultra-short pulse duration, so it means a cold laser that let them engrave or texturize over any material.

As it is a 5 axis machine, there is the possibility to create the shapes over any 3D surface.

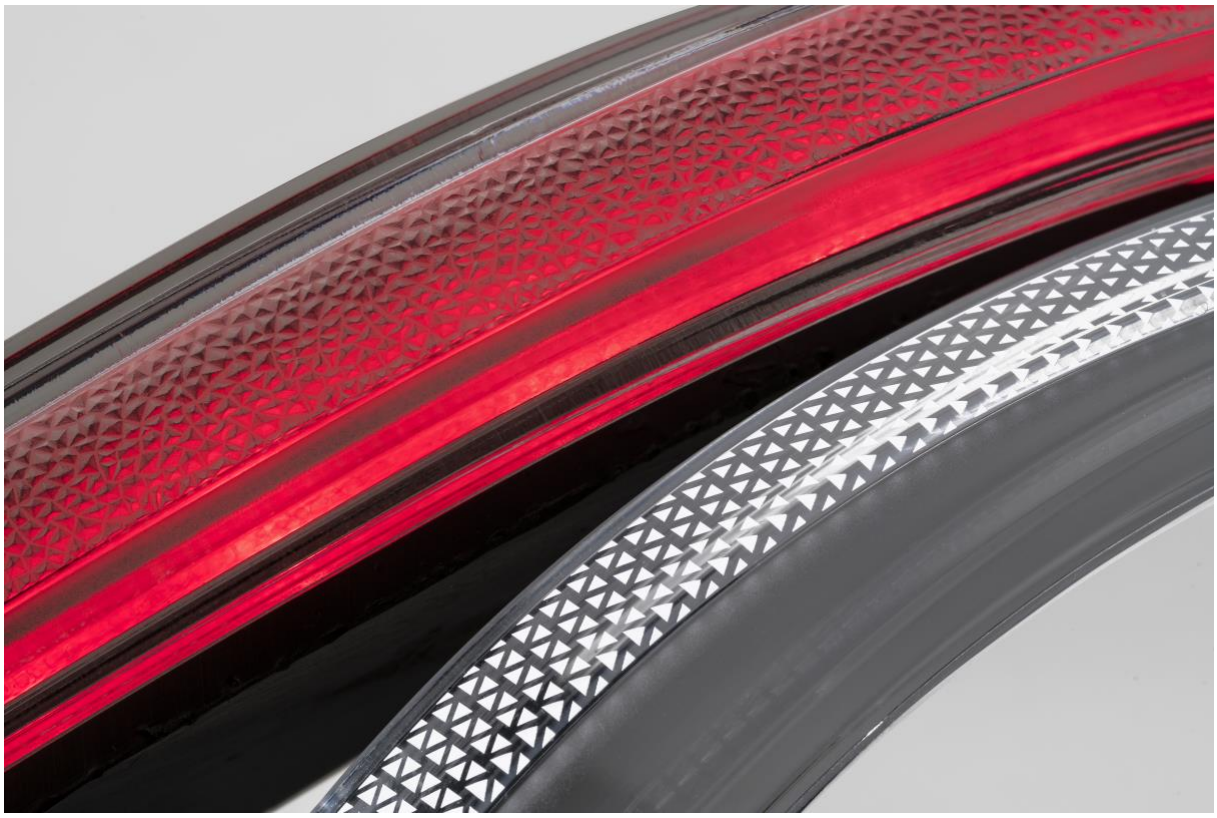

Fig. 4. Micro milling and decorative light diffusion texture over PMMA prototypes for automotive industry

