Laser-based surface functionalization of transparent materials by Direct Laser Interference Patterning technique

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Transparent materials hold immense potential for various applications ranging from optics to biomedicine, telecommunication, and sensing, necessitating precise control over their surface properties. In this framework, Direct Laser Interference Patterning (DLIP) emerges as a versatile technique for achieving subwavelength periodic structures with a high aspect ratio for a wide range of materials [1,2]. By exploiting interference patterning mechanisms, DLIP enables tailored surface functionalities such as anti-reflective, superhydrophobic, and anti-bacterial properties. Moreover, DLIP's compatibility with various transparent materials, including glass, polymers, and ceramics, underscores its versatility and potential for widespread application. Importantly, the technique raised interest in the last few years since it allows for minimising waste generation and chemical usage, contributing to a greener and safer manufacturing environment. Nowadays, DLIP appears to be the right compromise to achieve surface features with size down to a few 100s of nm while running at competitive throughputs. In this work, the DLIP technique is employed to produce functionalised fused silica, polycarbonate, and sapphire (Figure 1). A state-of-the-art processing setup is employed to shape the 100s-nm nanostructure features to obtain highly homogeneous morphologies in different regimes of interaction (laser pulse duration from 100s of femtosecond to a few picosecond). Various surface functionalities are validated to link the process parameters to the functional behaviour of the patterned surface.

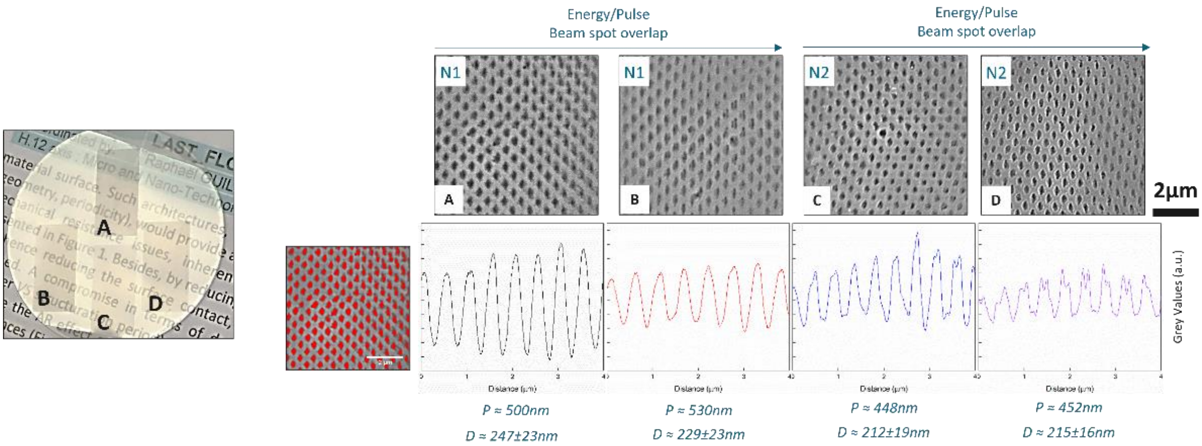

Figure 1: Surface functionalization of sapphire by DLIP technique for anti-reflective effect.

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