

# Surface Morphology at Nanometric Scale by Temporal and Polarization Control of Ultrashort Laser Pulses

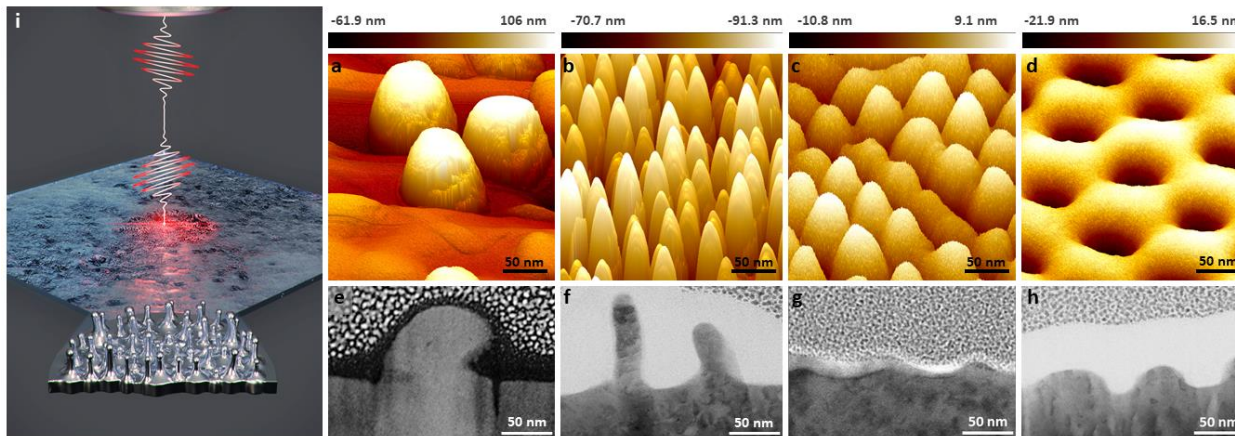
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## Abstract.

Ultrafast-laser irradiated surface is a typical paragon of a self-organizing system, which emerge and organize complex micropatterns and even nanopatterns. A spectacular manifestation of dissipative structures consists of different types of randomly and periodically distributed nanostructures that arise from a homogeneous metal surface. The formation of nanopeaks, nanobumps, nanohumps and nanocavities patterns with 20–80 nm transverse size unit and up to 100 nm height are reported under femtosecond laser irradiation with a regulated energy dose [1, 2]. We shed the light on the originality of the nanopeaks, having an exceptional aspect ratio on the nanoscale [3]. They are primarily generated on the crests grown between the convective cells formed by the very first pulses. The production of these distinct nanostructures can enable unique surface functionalizations toward the control of mechanical, biomedical, optical, or chemical surface properties on a nanometric scale [4-7]. We show that the use of crossed-polarized double laser pulse adds an extra dimension to the nanostructuring process as laser energy dose and multi-pulse feedback tune the energy gradient distribution, crossing critical values for surface self-organization regimes. Furthermore, the initial surface roughness and type of roughness is another essential feature to be controlled to switch from a regime of self-organization to another one.



**Figure 1.** 3D atomic force microscopy of the nanobumps (a), nanopeaks (b), nanohumps (c) and nanocavities (d) presenting the nanostructures height and distribution. (e-h) Transmission electron microscopy of the principles nanostructures presenting the cross view of nanostructures. (i) Schematic illustration of nanopeaks formation by femtosecond laser double pulse.

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