



**HAL**  
open science

## Modeling 2D and 3D periodic nanostructuring of materials with ultrafast laser pulses

Jean-Philippe Colombier, Anton Rudenko, Emile Bévillon, Hao Zhang, Tatiana Itina, Razvan Stoian

► **To cite this version:**

Jean-Philippe Colombier, Anton Rudenko, Emile Bévillon, Hao Zhang, Tatiana Itina, et al.. Modeling 2D and 3D periodic nanostructuring of materials with ultrafast laser pulses. Photonics West 2017, Jan 2017, San Francisco, United States. ujm-02018957

**HAL Id: ujm-02018957**

**<https://ujm.hal.science/ujm-02018957>**

Submitted on 19 Feb 2019

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

## Modeling 2D and 3D periodic nanostructuring of materials with ultrafast laser pulses

Jean-Philippe Colombier<sup>1,\*</sup> Anton Rudenko,<sup>1</sup> Emile Bévillon,<sup>1</sup> Hao Zhang,<sup>1</sup> Tatiana E. Itina,<sup>1</sup> and Razvan Stoian<sup>1</sup>

*1 Univ Lyon, UJM-Saint-Etienne, CNRS, IOGS, Laboratoire Hubert Curien UMR5516, F-42023 St-Etienne, France*

\*E-mail: [jean.philippe.colombier@univ-st-etienne.fr](mailto:jean.philippe.colombier@univ-st-etienne.fr).

Generation of periodic arrangements of matter on materials irradiated by laser fields of uniform and isotropic energy distribution is a key issue in controlling laser structuring processes below the diffractive limit. Using 3D-FDTD methods, we evaluate energy deposition patterns below a material's rough surface and in bulk dielectric materials containing randomly distributed nano-inhomogeneities. We show that both surface and volume patterns can be attributed to spatially ordered electromagnetic solutions of linear and nonlinear Maxwell equations. Transient electronic response is also analyzed and show that for nonplasmonic metals, ultrafast carrier excitation can drastically affect electronic structures, driving a transient surface plasmonic state.