The synergy of electromagnetic effects and thermophysical properties of metals in the formation of laser induced periodic surface structures

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Femtosecond pulsed lasers have been widely used over the past decades for precise materials structuring at the micro- and nano- scales. In order, though, to realize efficient material processing and account for the formation of laser induced periodic surfaces structures (LIPSS), it is very important to understand the fundamental laser-matter interaction processes. A significant contribution to the LIPSS profile appears to originate from the electromagnetic fingerprint of the laser source. In this work, we follow a systematic approach to predict the *pulse-by-pulse* formation of LIPSS on metals due to the development of a spatially periodic energy deposition that results from the interference of electromagnetic far fields on a non-flat surface profile. On the other hand, we demonstrate that the induced electromagnetic effects, alone, are not sufficient to allow the LIPSS formation, therefore, we emphasize on the crucial role of electron diffusion and electron-phonon coupling on the formation of stable periodic structures (Fig.1). Gold and stainless Steel are considered as two materials to test the theoretical model while simulation results appear to confirm the experimental results that, unlike gold, fabrication of pronounced LIPSS on stainless Steel is feasible.

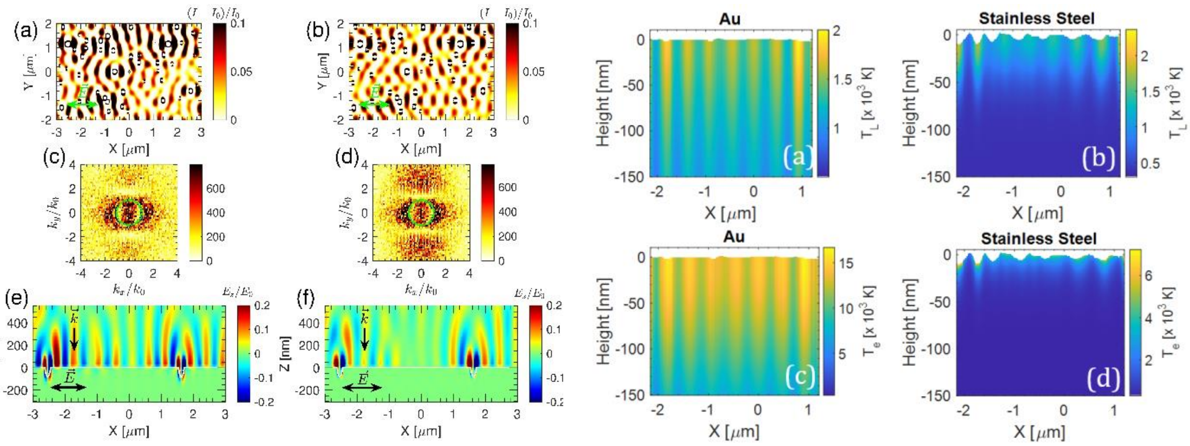

Fig.1: Absorbed energy distributions on the transverse plane for Au (*first* column) and Stainless Steel (*second* column) surfaces. Thermal effects on Au (*third* column) and Stainless Steel (*fourth* column) after four pulses.

References

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