Ultrafast laser-induced thermo-mechanical changes of Ti thin films on Si substrates

E. Tzianaki[1,2], Y. Orphanos[1], M. Bakarezos[1], G.D. Tsibidis[3], P.A. Loukakos[3], C. Kosmidis[2], M. Tatarakis[1], and N.A. Papadogiannis[1,*]

[1]*Centre for Plasma Physics & Lasers, School of Applied Sciences, Technological Educational Institute of Crete, Rethymnon 741 00, Greece*
[2]*Physics Department, University of Ioannina, 451 10 Ioannina, Greece*
[3]*Foundation for Research and Technology-Hellas, Institute of Electronic Structure and Laser (FORTH-IESL), P.O. Box 1527, 711 10 Heraklion, Greece*

Titanium (Ti) is a material for which theoretically calculated values of electron-phonon coupling constant are extremely high [1]. This makes Ti a favourable transducer for the conversion of absorbed ultrafast laser energy into high frequency mechanical waves. In this article, we present initial experimental results from thin Ti films on Silicon (Si) substrates, which support the previous theoretical calculations, and show interesting features both at the very early times of the interaction and, at later times, in which mechanical waves are created and propagate into the Ti film and the Si substrate. Preliminary theoretical modelling supports the extremely fast transfer of the electron energy to the lattice (of the order of 0.5ps) and addresses issues such as the role of the non-thermal electrons on the very early times of the interaction, as well as other dynamic features at later times such as rapid phase changes.

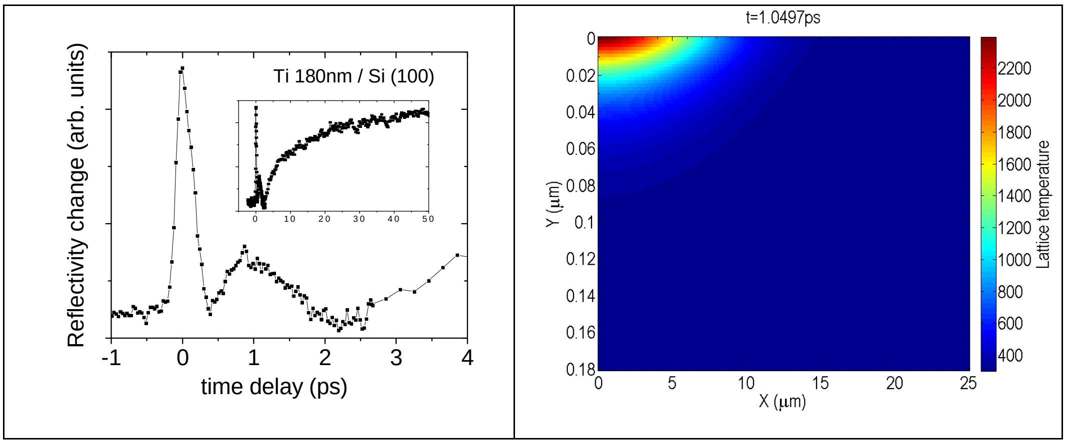

Figure 1: Left: Experimentally measured femtosecond transient reflectivity of a 180 nm Ti-film on Si (100) substrate at melting conditions. Right: Theoretical predictions for the temperature distribution inside the Ti film, at time 1.05 ps after the excitation. A melted depth of about 10 nm is illustrated.

References

[1] Z. Lin, L.V. Zhigilei, and V. Celli, Phys. Rev. B **77**, 075133 (2008).

[*] npapadogiannis@staff.teicrete.gr