Numerical simularion of laser ablation processes in pulsed regime.

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Laser ablation processes of different metals has been the subject of research in the last decades, as they have various applications in some technological fields. In particular, they are used in monolithic interconnection of thin film photovoltaic modules. In this work we have simulated ablation processes in both nano and femtosecoseconds pulsed regime. Firstly, we have used the softawe COMSOL MULTIPHYSICS to solve the temperature evolution of a Copper piece irradiated by nanosecond pulses. Then, the molten phase was also modelled. This was already done by Chevallier et al. [1] for stainless steel, however, we have added multipulse regime with cooling phase as well as a temperature-dependent reflectivity.

Secondly, we have performed the same simulations by creating a (more computationally efficient) MATLAB code. Then, we have also used this language to simulate femtosecond regime. For doing that, the Two Temperature Model (TTM) [2] needed to be implemented. In this occasion, a silver piece was chosen for simulations. In both femto and nano second regime, a downward mesh velocity was defined to simulate the ablation process, considering the energy balance. The optical properties of the metals were obtained by using the Critical Point Model (CP) [3].

[1] Chevallier, E. C., Vincent Bruyére, TianLong See and Patrick Namy. “Laser texturing modelling using COMSOL Multiphysics ®." (2018)
[2] Prokhorov A.M., Konov V.I., Ursu I. and Mihailescu I.N. Laser Heating of Metals. London: Institute of Physics Publishing. 1990.
[3] Barchiesi, Dominique & Grosges, Thomas. (2014). Fitting the optical constants of gold, silver, chromium, titanium, and aluminum in the visible bandwidth. Journal of Nanophotonics. 8. 083097.

Figures

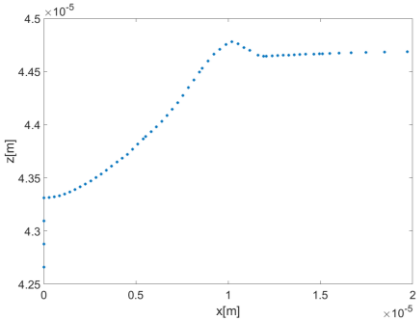

Figure 1: Ablation curve for copper piece, 12 ns laser, the molten phase was also modelled.

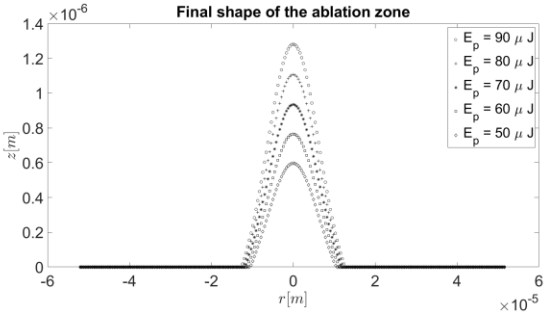

Figure 2: Ablation curves for silver piece, 350 fs laser, varying energy per pulse.