RESIDUAL ENERGY MEASUREMENT AT PICOSECOND LASER IMPACT ON METALS*

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Residual energy or thermal coupling coefficient shows what fraction of laser pulse energy is spent for target heating. High residual energy rates lead to low impact efficiency and sometimes to unwanted effects like phase transitions and chemical reactions. Experimental works on its measurement at nano- and femtosecond laser impact are not numerous but still can be found, while picosecond range is poorly studied. The latter is interesting since thermal coupling effects are close to ultrashort impact, while lasers efficiency, complexity, and price are closer to nanosecond devices. Existing numerical simulation results appear to be underestimated die to lack of available experimental data. Residual energy is usually evaluated using target temperature measurement, containing methodical errors, for pulse trains particularly, since actual absorbed energy fraction is unknown, temperature field across the target is complicated, and for pyrometry – exact emissivity is not known. To overcome this, we have used calorimeter to evaluate heat flux through a target at focused and non-focused irradiation. Such approach, to our mind, reduces errors.

Data obtained for Aluminium at 1064 nm, 71 ps, 15 Hz irradiation are of high novelty and is significant for proper thermal coupling modelling and adequate transition from lab modelling to real-world systems using pulse-periodic picosecond impact. The results evidence big need for experimental data on realistic laser technology impact regimes for adequate modeling, residual energy, and efficiency evaluation. Thermal coupling coefficient depends not on target material and pulse length, but on the whole set of impact conditions.

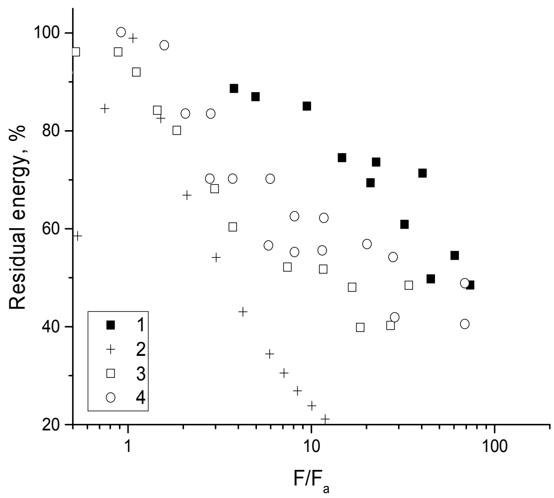

Fig.1. Residual energy data normalized by absorptivity A of Al target as a function of laser fluence F normalized by ablation threshold F_a: 1 – our data, F_a=4 J/cm^2; 2 – calculated for 1064 nm, 100 ps single pulse, A=0.20, F_a=0.7 J/cm^2 [1]; 3 – for 1064 nm, 55 ns single pulse, A=0.25, F_a=2.7 J/cm^2 [2]; 4- for 800 nm, 60 fs single pulse, A=0.37, F_a=0.058 J/cm^2 [2].

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