Wigner 121
Scientific Symposium

Wigner Research Centre for Physics
Institute For Particle And Nuclear Physics
Nanoplasmonic Laser Fusion Laboratory
Spectroscopy Group

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Introduction

UDMA (Urethane dimethacrylate, $C_{23}H_{38}N_2O_8$) based polymers with and without implanted plasmonic nanonatennas were exposed to femtosecond laser irradiation with different pulse energies. The laser-matter interaction produces plasma plum which facilitates in-situ LIBS measurements to study the target composition. Due to the effective energy utilization of the laser pulse in presence of resonant nanoparticles, enhanced crater formation was observed and the surface enhanced Raman spectroscopic measurements on the crater walls indicate unique structural changes in the target.

Materials and Methods

Materials

- Urethane dimethacrylate-triethylene glycol dimethacrylate (UDMA-TEGDMA) photo-polymer, 160-240 nm thickness.
- Gold nanorods with 25 × 85 nm size.

Methods

Irradiation

- Ti:Sapphire-based chirped-pulse two-stage amplifier-laser system (Coherent Hydra) in argon-filled vacuum chamber with 42 fs pulse length, 795 nm central wavelength

Morphological changes

- White light interferometry
- Scanning electron microscopy

Changes in bonding properties

- Raman micro-spectroscopy
- Laser-induced breakdown spectroscopy

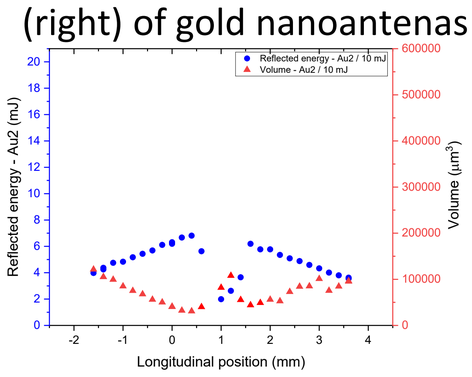
Publications

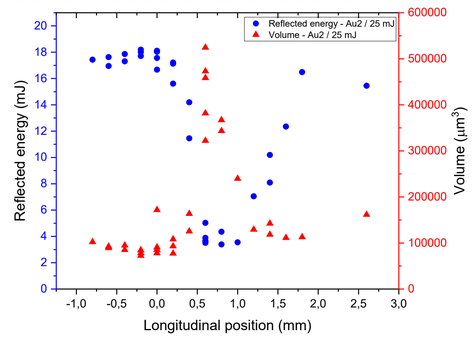
[1] A.Bonyár et al.: *The Effect of Femtosecond Laser Irradiation and Plasmon Field on the Degree of Conversion of a UDMA-TEGDMA Copolymer Nanocomposite Doped with Gold Nanorods*, Int. J. Mol. Sci. 2022, 23(21)

[2] I. Rigó et al.: *Raman spectroscopic characterization of crater walls formed upon single-shot high energy femtosecond laser irradiation of dimethacrylate polymer doped with plasmonic gold nanorods,* 2022. Oct., ArXiv:2210.00619

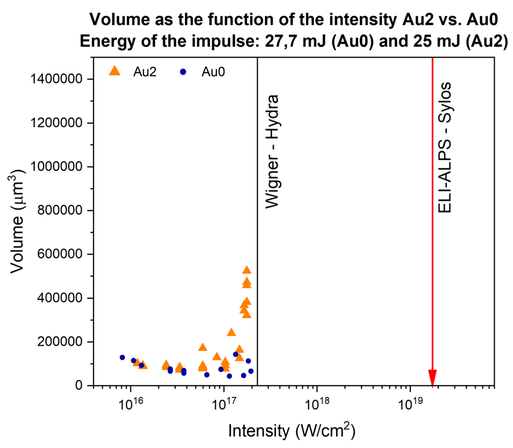
Results

The proper focusing decreases the reflected energy leading to larger craters. The absence (left) and presence (right) of gold nanoantenas also affects the craters.

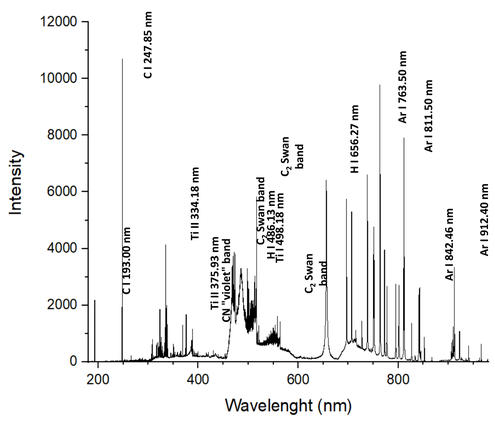


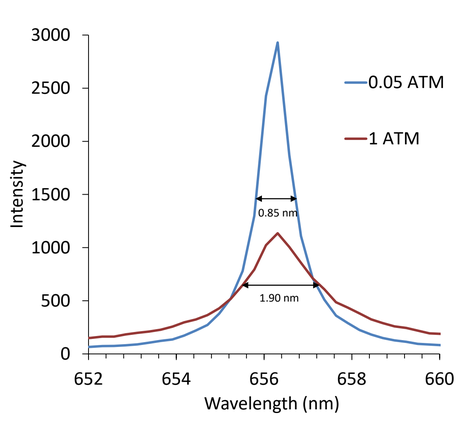


The crater volumes increase rapidly at higher intensities in samples embedded with gold nanorods. In samples without gold nanoparticles this effect is negligible.

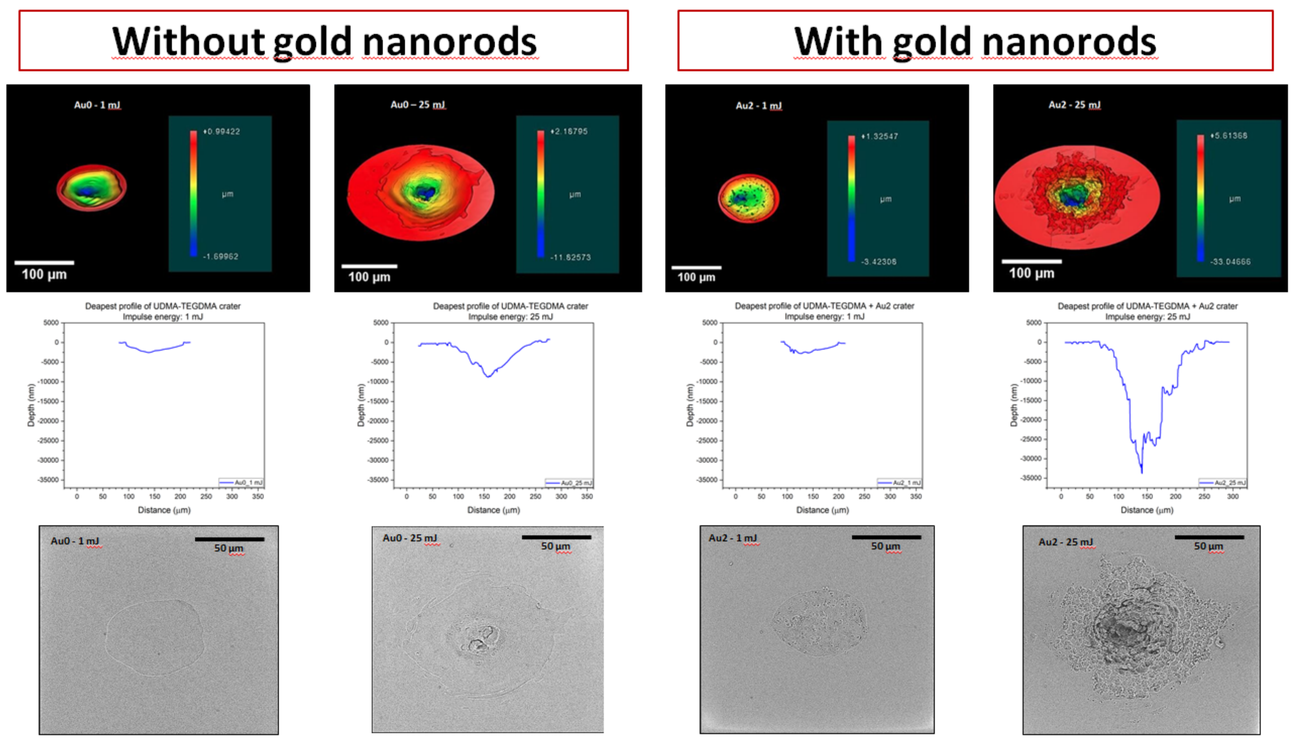


LIBS spectra taken in situ on the evaporated UDMA structure inform us about the elemental composition of the sample.





By increasing the energy of the laser pulse the crater's size (diameter, depth, volume) and roughness increases. The changes are significantly higher in case of the samples doped with gold nanorods.



Differential Raman spectra of the crater walls and the non-irradiated polymer structure show new Raman bands in the samples doped with plasmonic nanoantennas (UDMA-X denotes the sample without gold).