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MORPHOLOGICAL STUDY OF SILVER IN THE CONDITIONS OF ULTRASHORT LASER ABLATION IN LIQUID

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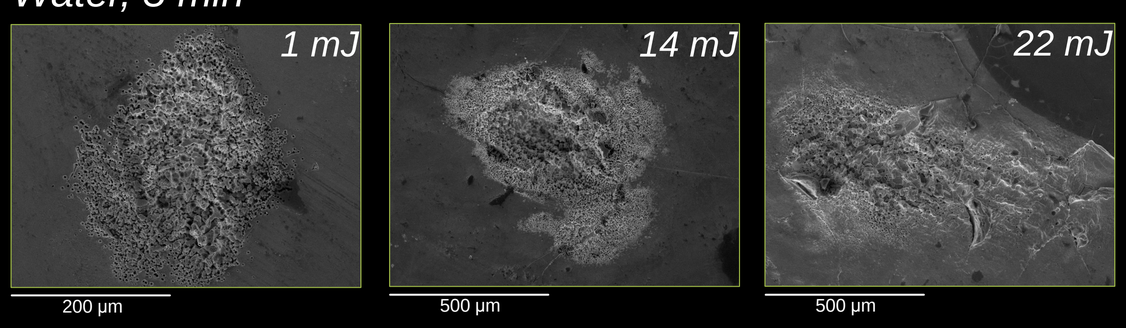
The study deals with morphological effects on the silver target irradiated with ultrashort laser pulses in liquid (water). Synthesis of metal nanostructures (NS) by laser ablation in liquid is a relatively new method with benefits including clean production, without the use of additional chemicals necessary in conventional techniques, obtaining of pure particles with no surfactants, and good stability of the colloid. There are fewer studies, however, concerning the effects on the target itself during the laser action, and this type of research could lead to a better understanding of the physics involved and therefore better control of the process by linking the induced morphological features with NS synthesis results – yield, size distribution, etc. Also, reports on the laser ablation parameters of silver in liquid environment are scarce and significant for every particular set of parameters (laser pulse length, other laser parameters, liquid type).

- Ag target was irradiated with laser pulses ***40 ps*** long, at ***1064 nm*** wavelength and ***10 Hz*** repetition rate. Irradiation time was ***5 min***, and pulse energies ranged from ***0.5 mJ to around 22 mJ***.
- Surface features were distinctly different than in air with ***sponge-like structure***.
- Damage threshold fluence was determined to be around 0.7 J/cm^2.
- Submicron particles were synthesized for all energies above 1 mJ and their size varied from tens of nanometers to ~200 nm. Optimum results were obtained for energies ~14-17 mJ.
- Ablation depths were in the range of 30 to 100 μm for the above mentioned energy range.

SURFACE MORPHOLOGY - SEM:

Water, 5 min



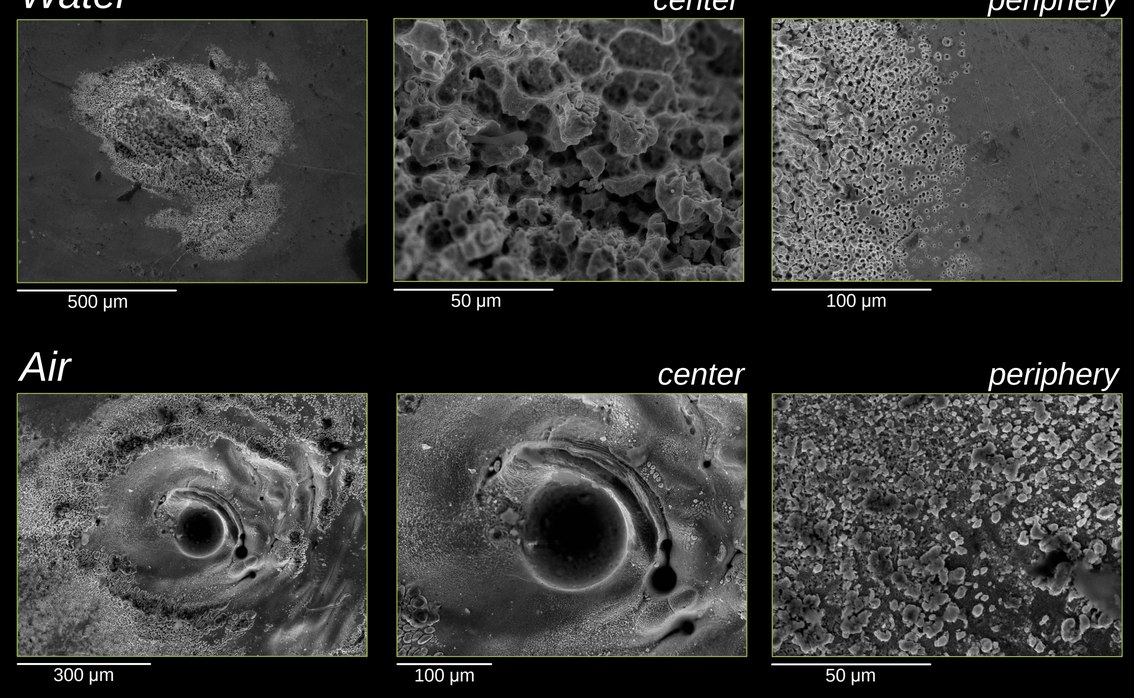
Ablation threshold:

$$D^2 = 2\omega_0^2 \ln\left(\frac{F_0^{pk}}{F_{th}}\right) = 2\omega_0^2 ln\left(\frac{E_p}{E_{th}}\right)$$

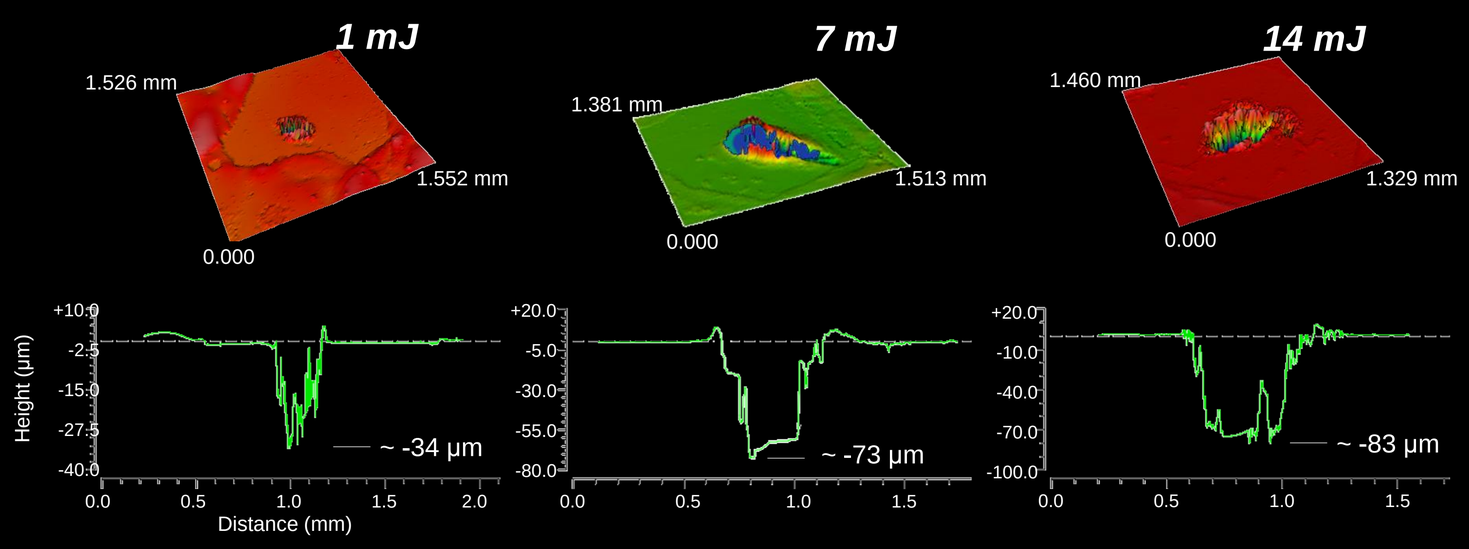
F_{th} = 0.7 J/cm²
E_p = 0.73 mJ

D - damage diameter, F_0^{pk} - fluence, ω_0 - laser beam radius, E_p - laser pulse energy. F_{th} and E_{th} are threshold fluence and threshold pulse energy. Peak laser fluence F_0^{pk} is given by the relation $F_0^{pk}=2E_p/(\pi\omega_0^2)$.

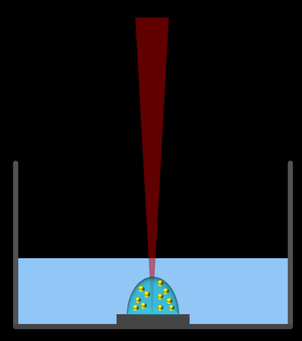
Water vs. Air (5 min, 14 mJ):

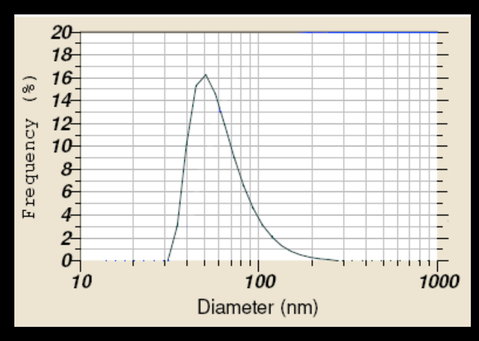


PROFILOMETRY:



SYNTHESIS OF NANOPARTICLES BY Laser Ablation in Liquid (LAL):





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