Report on the outcomes of a Short-Term Scientific Mission

Action number: CA20129

Grantee name: Biljana Gaković

Reference: E-COST-GRANT-CA20129-40f9f33d

Details of the STSM

Title: Ultrafast laser surface modification of Ni based nano layer thin films

Start and end date: **25/09/2023 to 05/10/2023.**

Description of the work carried out during the STSM

During STSM visit the CETAL laboratory (National Institute for Laser, Plasma, and Radiation Physics (INFLPR) in Bucharest, Romania) we conducted the experiment connected with laser irradiation of the samples in the form of multi-layer thin films (MLTFs). The used MLTFSs were 5x(Ni/Ti)/Si, 16x(Ni/Ti)/Si and 5x(Al/Ti)/Si). The host dr Marian Zamfirescu, has prepared the complex set-up, for the proposed study. The laser irradiations were done with two laser wavelengths, 532 and 355 nm, the pulse duration of 5 ps, and repetition rate of 500 kHz. All measurements were performed in the laboratories' clean room, in the air. Firstly, we did a parametric study with one sample to find an interval of the laser power and exposure time which are the best for selective remove a nanolayer or few of them from the surface of the MLTFs. Optical microscopy analyses (OMA), at high magnification, helped us to find the proper interval of laser parameters for achieve the proposed surface modification. The power point presentation was prepared from OMA and irradiation conditions data. After that, we chose the best combination of the power and number of delivered pulses to achieve the selective ablation and the surface modifications. The complete serial of irradiations was done with the samples using these established conditions. Selective removal of the single layer or a few of them was achieved only combining the low laser power and short exposure times. Apart this selective ablations we successes to produce laser induced periodical surface structures (LIPSSs). LIPSSs were formed on the different layers of MLTFs with orientations that depend on the exposure time-power combinations. Atomic force microscope (AFM) was chosen to revile the spots details, as height of the steps and total depth of ablated areas. Scanning electron microscopy (SEM) technique was used for reveal morphological details on the spots.

Description of the STSM main achievements and planned follow-up activities

The main goal of the proposed STSM grant was to strengthen the network by re-establishing and maintaining collaboration between our institutions, which are the National Institute for Laser, Plasma, and Radiation Physics (INFLPR) in Bucharest, Romania, and Vinča Institute of Nuclear Sciences in Belgrade, Serbia. I have had the opportunity to collaborate closely with Marian Zamfirescu, an expert in the field of laser material processing, and to use the laser equipment and equipents for surface characterization that his laboratory has had.

The proposed investigation was carried out with the new established setup. The thin films treatment experiment would be conducted in the future using it. We did not have enough time to do all the planned surface characterizations with all samples. My host will continue characterizations using SEM and AFM analyses. He will share the results through the internet. For communication regarding the obtained results, an internet conference will be established between us. When the proposed experiment was over, we made the decision to keep mutual collaboration to process other MLTF combinations using the same equipment. The special interest relates to irradiations of MLTFs composed of Si and metal nanolayer (Si/Ti, Si/Ni). There is little information available on this type of experiments, it could be very valuable from the theoretical and application points of view.

The investigation's findings should advance the understanding of how lasers interact with metalic samples in the form of nano layer thin films. Particularly, ultrafast laser irradiation experiments can improve the ability to produce micrometer-sized structures on thin films for a range of applications. The dissemination of research findings through presentation at a significant international conference and publication in a peer-reviewed journal would be the expected output.