Report on the joint experiment on: Italy - Poland bilateral collaboration performed at the Department of Physics, University of Milano-Bicocca during 9 - 14 November, 2009.

The visit in the framework of the approved project n.2 “Study and Application of Laser produced Plasma”, included in ANNEX II of the XIX Executive Programme of Scientific and Technological Co-operation between the Republic of Italy and the Republic of Poland for the years 2007-2009 took place between 9th and 14th of November, 2009 at the Department of Physics, University of Milano-Bicocca in Italy.

During the visit a laser induced forward transfer (LIFT) was studied. The main goal of the experiment was to saw an aluminum trace on an agate mineral with the ose of pico-second laser pulses. The LIFT method is presented in fig.1. In the first step (a) the laser pulse impinges on a donor film, vaporizing a portion of the film (laser ablation), then (b) the expansion of the plasma ejects a piece of donor film at high velocity and in the last step (c) the ejected film is impacted and bonds with the acceptor substrate.

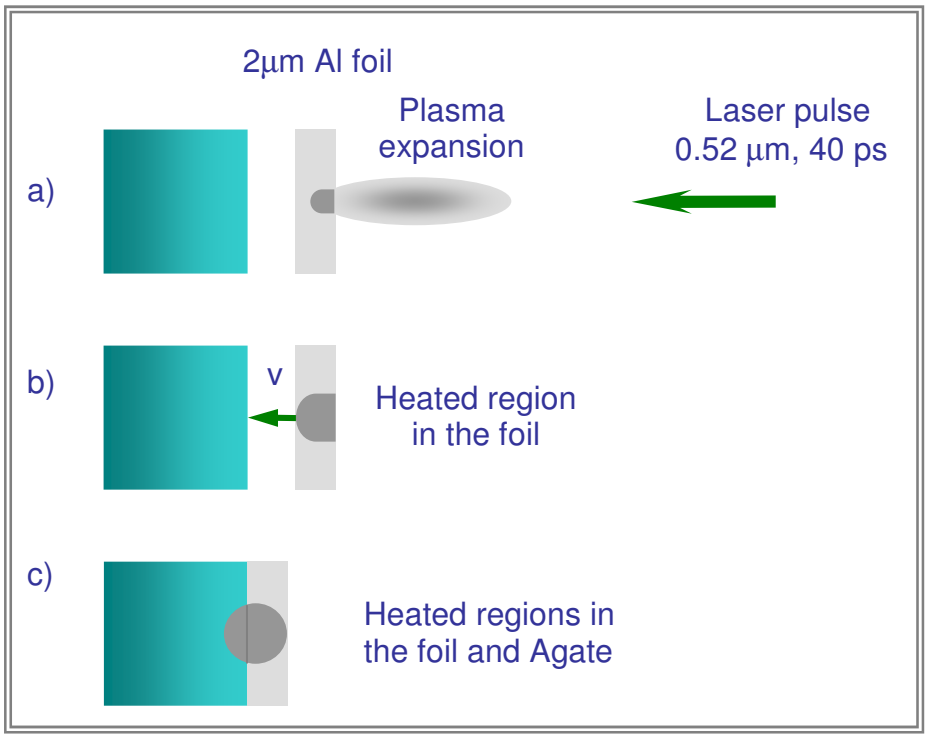

Fig.1. The phases of LIFT

Experimental set-up

A second harmonic of the Nd:YAG laser system (SYL P2 produced by Quanta System Srl, Solbiate, Italy) consisting of a laser oscillator, an amplifier and a nonlinear crystal KDP was used. The system operates with a repetition frequency from 0.5 to 10Hz or with single shots with a pulse duration of about 40 ps with energy 20 mJ. A thick 2μm Al foil attached to an agate mineral was used as a target. The foil was located ≤ 50 μm from the agate surface. Figure 2 presents position of the target and the laser beam. The target was placed perpendicularly to the laser beam, which could be moved along the *x* direction by external motions. The laser beam passed through a quartz lens which could be remotely moved along the *z*-axis with an external digitally controlled micrometric motion.

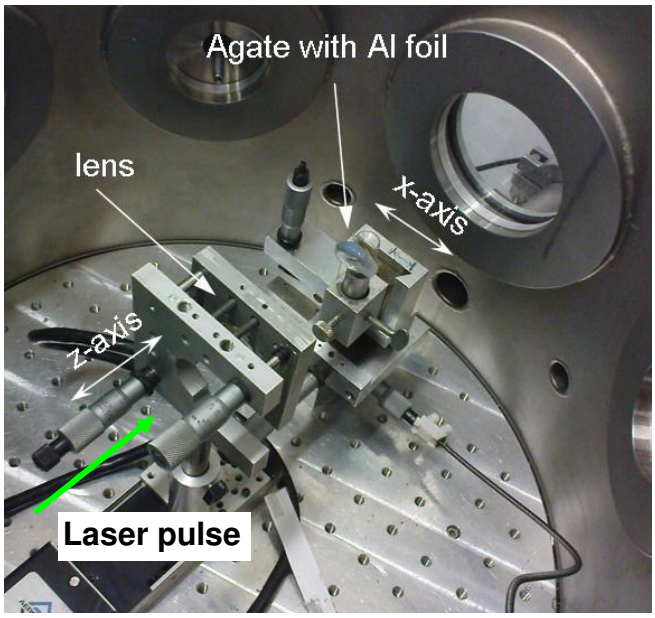

Fig.2. A photo of a target and lens location.

Experimental results

A series of measurements were performed using different distances between the lens and the target for various frequency of laser pulses. The experiment was prepared in air at room temperature. The presented results were obtained with a lens of the focal length of 9 cm, placed at the distances 6, 8 or 9 cm from the target. To observe differences between results obtained in these conditions an optical microscope images of Al deposited on Agate were obtained. The results are presented in fig. 2.

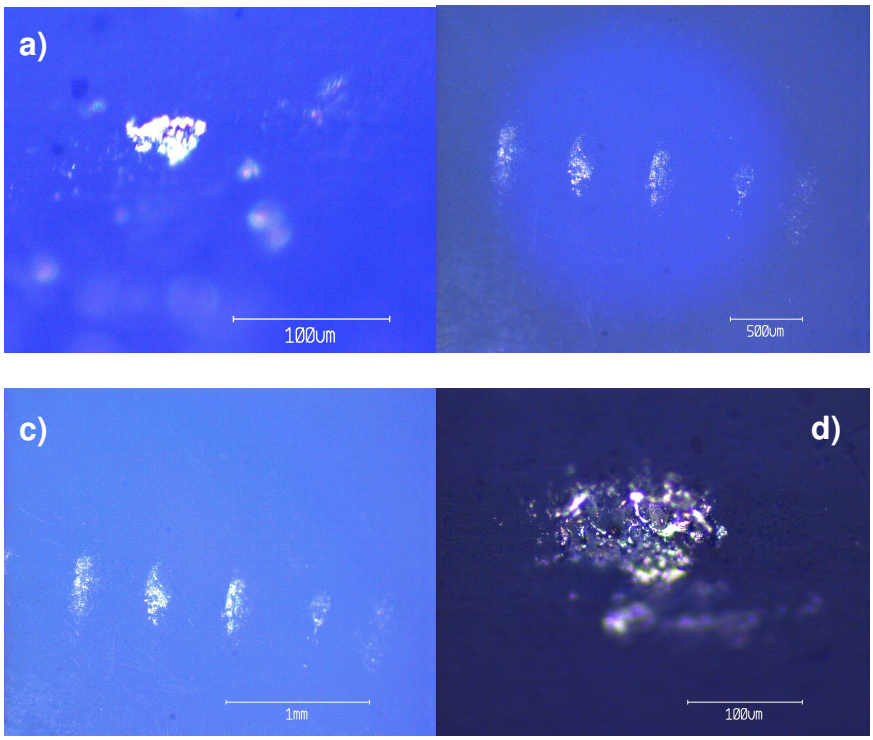

Fig.2. Optical microscope image of the deposited Al on Agate at different experimental condition: a) distance between lens and the target was 6 cm and repetition frequency was 0.5 Hz; b) distance between lens and the target was 8 cm and repetition frequency was 0.5 Hz; c) distance between lens and the target was 8 cm and repetition frequency 2 Hz; d) distance between lens and the target was 9 cm and repetition frequency was 2 Hz.

The images above show that better results can be obtained for the higher repetition frequency of the laser system, cases c and d. A better deposition of Al is also obtained for 8 cm distance between lens and the target. In that case the diameter of deposited Al is the biggest one.

Optical microscope images show that much more aluminum is deposited not exactly when the lens is located in the focal point but when the focal point was located behind the target. In the future it will be interesting to see the results in case when the focus point is located in front of the target.

Nevertheless, obtained results seem encouraging about LIFT technique as a possible approach satisfying the needs of jewellery industry.