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 placed between 9th and 14th of November, 2009 at the Department of Physics, University of Milano-Bicocca in Italy.

Laser induced forward transfer (LIFT) was studied. An active-passive mode-locked Nd:YAG laser system (SYL P2 produced by Quanta System Srl, Solbiate, Italy) consisted of a laser oscillator, an amplifier and a nonlinear crystal KDP was used. The system can operate with a repetition frequency from 0.5 to 10Hz or in single shots with a pulse duration of about 40 ps with energy 20 mJ. As a target it was used a thick 2μm Al foil attached to an agate. The foil was located ≤ 50 μm from the agate surface. The target was placed perpendicularly to the laser beam, which could be moved along the *x* direction by external motions (see fig.1). The laser beam passed through a quartz lens which could be remotely moved along the *z*-axis with an external digitally controlled micrometric motion.

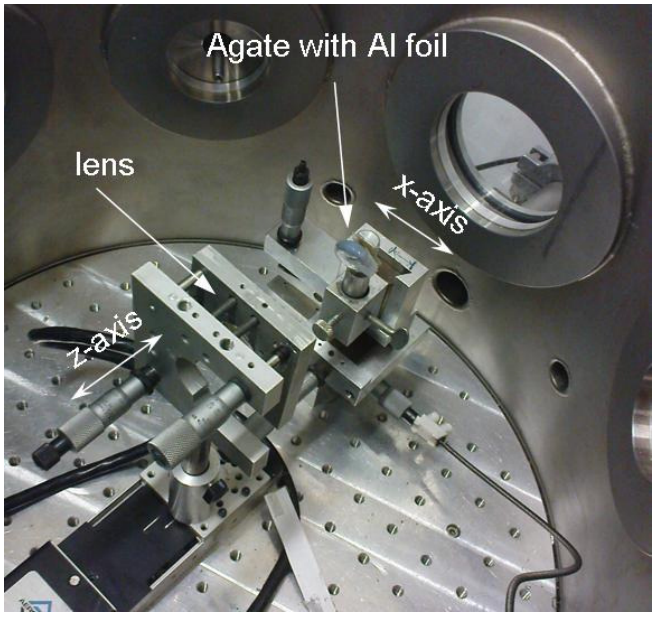

Fig.1. A photo of target and lens location.

A three series of measurements were performed at different experimental conditions. The presented results were obtained with a lens of the focal length of 9 cm, placed at the distances 6, 8 and 9 cm from the target. To irradiate the target the second harmonic 0.52 μm of the Nd:YAG laser system was used. Optical microscope images of Al deposited on Agate at different experimental condition are shown in fig. 2. The experiment was conducted in air at room temperature.

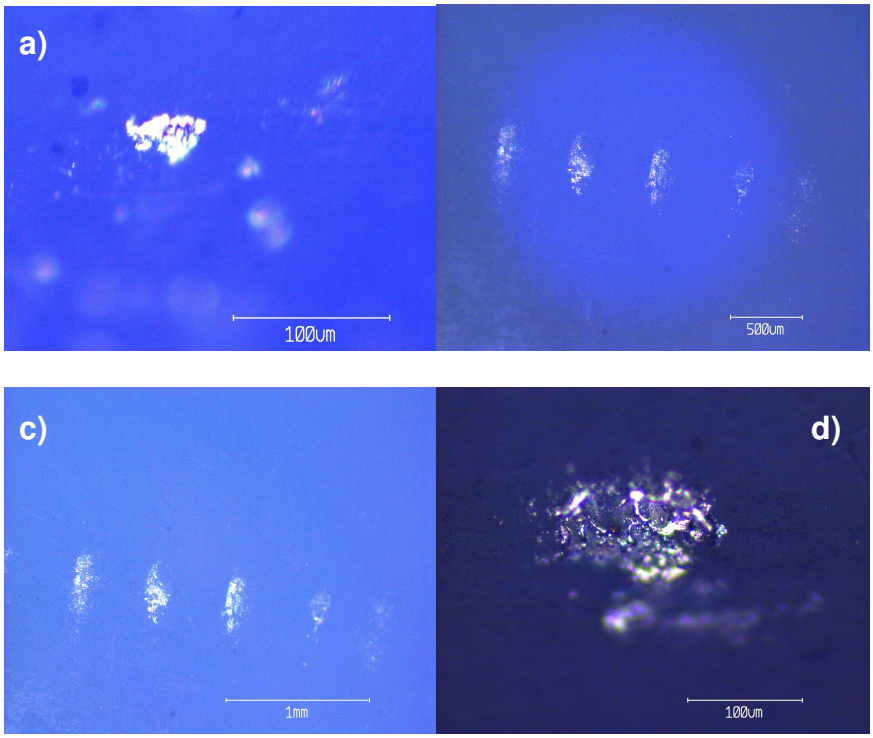

Fig.2. Optical microscope image of the deposited Al on Agate at different experimental condition: a) distance between lens and the target was 6 cm and repetition frequency was 0.5 Hz; b) distance between lens and the target was 8 cm and repetition frequency was 0.5 Hz; c) distance between lens and the 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 a higher repetition frequency of laser system, cases c and d. Also better deposition of Al was obtained for 8 cm distance between lens and the target. In that case the diameter of deposited Al is the biggest one.

Generally, laser induced forward transfer could be describe in 3 steps:

- the laser pulse impinges on a donor film, vaporizing a portion of the film (laser ablation),
- the expansion of the plasma ejects a piece of donor film at high velocity
- the ejected film is, impacted and bonds with the acceptor substrate.

These steps are presented in Fig.3.

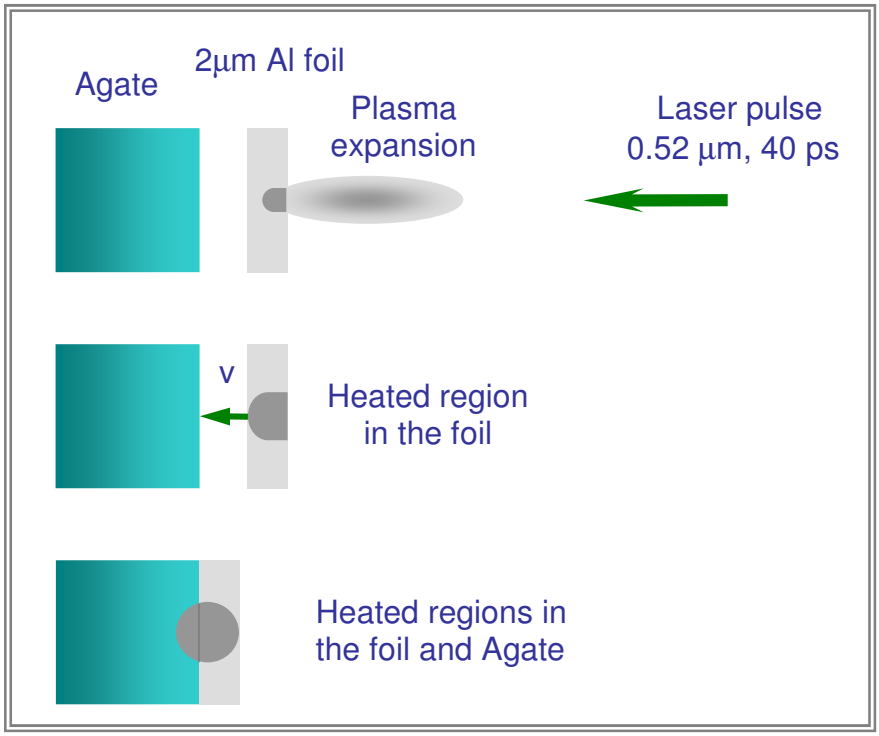

Fig.3. Different phases of LIFT

Optical microscope images show that much more aluminum was deposited not exactly when the lens was 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.