Stage II - 01.12.2008

Realization of polymer and oxide structures by LIFT

Objectives of the execution stage

1) the completion of the experimental setup through the acquisition of a nanosecond pulsed laser, working at 193 nm (ArF excimer laser), and a Secondary Ion Mass Spectrometry (SIMS) system;

2) the deposition of oxide thin layers by laser ablation and radiofrequency discharge assisted laser ablation;

3) the deposition of polymer thin films by MAPLE;

4) LIFT experiments using nanosecond and femtosecond pulsed lasers of single component materials (metals), complex oxides, polymers, heterostructures;

5) the characterization of the transferred material using AFM, STM, dielectric spectroscopy, and SIMS techniques.

Summary

During this stage two systems necessary for the achievement of the project objectives were acquired: an ArF excimer laser, purchased from SC APEL LASER SRL, and a SIMS system, purchased from HIDEN ANALYTICAL LTD.

Thin layers of PIB (polyisobutylene), PEI (polyethyleneimine), and PECH (polyepichlorohydrin) on quartz transparent substrate were obtained by Matrix Assisted Pulsed Laser Evaporation (MAPLE). Three independent sets of targets were created for the deposition of PIB, PEI, and PECH polymer thin layers: PIB - dissolved in toluene (2% concentration), PEI - dissolved in methanol and ethanol (1% concentration), and PECH - dissolved in acetone (1% concentration). Two laser wavelengths were employed to irradiate the targets, 266 nm and 355 nm. Quartz plates were used as substrates, placed at 4 cm away from the target. The substrates were not heated during the depositions. All depositions were carried out in vacuum, at a pressure of approximately 10^{-4} mbar. The films were investigated morphologically and structurally. The majority of the deposited samples resulted in uniformly covered PIB, PEI, and PECH films.

Zinc oxide thin films were deposited on transparent substrates by laser pulsed deposition (PLD) and radiofrequency discharge assisted PLD for subsequent LIFT (Laser Induced Forward Transfer) experiments. The ZnO thin films were deposited from ceramic ZnO targets or metallic Zn targets onto transparent sapphire and MgO substrates, positioned at approximately 4-5 cm from the target. The depositions occurred at a pressure of 0.05 mbar in oxygen, either radiofrequency discharge assisted or not.

The deposition temperature varied between 100° and 500° C, and the laser fluence was between 2.5 and 4 J/cm^2 for the depositions using ultraviolet radiation, and approximately 20 J/cm^2 for the experiments conducted using an infrared laser source. The employed wavelengths were the fundamental and the 4th harmonic of the Nd:YAG laser. The experiments performed during this activity were a preparation for the upcoming stage (LIFT experiments on zinc oxide).

The LIFT experiments were conducted at pulse energies of 100, 50, 40, and 25 nJ, respectively, and sample movement speeds of 0.1, 0.05, 0.01, and 0.005 mm/s, using a 775 nm laser source with a pulse repetition rate of 2 KHz and pulse duration of 180 fs. The data extracted

from the AFM measurements reveal that the thickness of ZnO thin film was approximately 90 nm, and the width of the created structure is of 3 μm.

The multilayer polymer films were obtained by spin coating, using quartz plates onto which a triazine layer was initially deposited, followed by the growth of a PEI layer. The final thickness of the multilayer film was 120-140 nm. The transfer was obtained using an excimer laser. The donor surface (target) and the receiving surface were placed in contact on motorized micrometric table. The fluence was varied between 7 and 900 mJ/cm^2. The optimal transfer regime of the polymer was identified.