INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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Programme of Study	:	**Ph.D.**

Thesis Title: **Spectroscopic studies on laser-induced plasma and surface characterization of copper in an externally applied static magnetic field at atmospheric pressure.**

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SHORT ABSTRACT

The objective of the present thesis is to investigate the laser ablation and laser produced plasma of copper in the absence and presence of magnetic field in air atmosphere. The optical emission spectroscopy is used to optimize the laser fluence and magnetic field for subsequent studies. The temporal evolution of copper transitions (neutral) studied showed multi-component structures. Without magnetic field and at 0.1 T the temporal profile of copper consists of two components and at higher magnetic field of 0.3 and 0.5 T, a third component is observed. The sample-to-focus distance of laser focusing lens affects the dynamical behavior of plasma in the presence of magnetic field. The optical emission enhancement is found to be maximum when the focus-to-sample distance is 5 mm. The increase in the ablated volume of laser induced craters in the presence of magnetic field is due to the increase in melt ejection as a result of increase in recoil pressure on the melted layer. The other possibility is the increase in plasma-target heat transfer which leads to further ablation. Therefore, to understand the dependence of laser ablation enhancement on the thermo-physical properties of the material, studies are reported on copper and aluminum. The increase in ablation is more pronounced in aluminum having low melting/vaporization temperature and high absorption coefficient of laser radiation. The investigation of the deposited particles on copper target shows the presence of Cu/CuO/Cu_2O crystal nanoparticles. The transformation of Cu_2O to CuO in the presence of magnetic field is in good agreement with X-ray diffraction, Raman, and photoluminescence studies. The laser ablation is further studied by creating the craters with higher number of laser shots in the presence of uniform and non-uniform magnetic field. The minimum size of droplets is estimated to be 0.68 μm. The droplet size increased (> 0.68 μm) in the presence of magnetic field as compared to without magnetic field. The percentage of large sized droplets increased in the presence of non-uniform magnetic field due to melt ejection and instability of liquid layer formed in the crater surface. It is attributed to an additional drift between the liquid layer and plasma which enhances Kelvin-Helmholtz instability. Finite element method is used to simulate laser heating in copper and aluminum targets using 2 dimensional heat conduction equation. The vapor pressure in the presence of magnetic field is estimated by adding magnetic pressure in the Clausius-Clayperon equation and results from this modified equation are found to be in close agreement with that obtained from the experiment. The dependence of laser ablation on thermo-physical parameters is also in good agreement with the experimental results. The ablated volume estimated experimentally is very close to the volume estimated from simulation signifying the validity of modelling used in present thesis. Therefore the reported work will be very useful to better understand the nanosecond laser ablation and laser plasma in the presence of magnetic field in air. The laser plasma with magnetic field can be used as a controllable atom source. It will be useful to improve the sensitivity in LIBS in the presence of magnetic field by increasing signal-to-noise ratio. An external magnetic field can be used to improve laser ablation and to transform the phase of copper oxide. The modeling introduced would be beneficial to understand the laser drilling and welding processes during the interaction of laser with the material.