Laser -induced plasma as a reliable and versatile tool for material processing

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Laser-induced plasma is highly beneficial, reliable and versatile tool for material processing. The theme for 2025 is “Light, Innovation, Society”, highlighting the central role of light-based technologies in advancing science, innovation, and societal well-being. Two kinds of laser systems i.e. Nd:YAG (1064nm, 532 nm, 10ns) and Excimer laser (308nm, 20ns) irradiations are used for the generation of plasma by using various metallic, semiconducting and insulating materials. The indigenously designed various plasma diagnostic techniques such as Faraday Cup, Solid state nuclear tack detection, time of flight mass spectrometry, laser-induced breakdown spectroscopy have been successfully employed for evaluation of ion energy and fluence. The laser intensity, number of pulses , environmental conditions and confinement techniques can control the doze/fluence and energy of laser induced plasma ions. Selective results related to laser -induced plasma as a tool for material processing. Scanning Electron Microscopy, Optical Microscopy, Confocal Microscopy analyses reveal that the plasma ions cause growth of various surface structures such as hillocks, bumps, pores, explosions, dendrites, cracks, tracks, grains and chains and on the surface of variety of materials. The surface structuring, electrical , optical, mechanical modifications along with wettability and field emission properties of ion-irradiated materials are strongly dependent upon both ions nature, energy and fluence along as well as on the physical properties of substrate. The significantly pronounced effects of magnetically confined laser induced plasma ions on the surface, optical, wetting, electrical and mechanical properties of polymeric material as compared to unmagnetized plasma also highlights the importance of plasma confinement. These modified and structured materials are potential candidates for various industrial and scientific applications such as field and thermionic emitters, conducting polymers and black metals.