ABSTRACT

Optimization of momentum coupling coefficient (C_m) is a major concern in Ablative Laser Propulsion. The present work deals with the study of ferrites as ablative laser micro-propellants. It also reports the effect of confinement on ablation parameters of ferrites.

In the first set of experiment, a novel idea of manipulating the momentum coupling coefficient (C_m) using lateral confinement of laser induced plasma and shock wave reflection from the cavity walls has been introduced. The plasma is confined using cylindrical geometries of various cavity aspect ratios to manipulate the C_m. The pulsed Nd: YAG laser (532 nm, 5 ns pulse duration) is focused on manganese ferrite sample surface to produce plasma in a region surrounded by cylindrical cavity walls. The multiple reflections of the shockwaves from the cavity walls confine the laser-induced plasma that subsequently results in a significant enhancement of the momentum coupling coefficient. Compared with the direct ablation, the confined ablation provides an effective way to obtain high C_m values.

In the second experiment, the effect of surface morphology on laser ablation propulsion is observed using three different morphologies, viz. initial (nanoparticles), intermediate (nano-noodles) and final (complete nano-noodles) of zinc oxide, as laser ablation micro-thrusters. For each sample, the laser fluence for the optimum coupling coefficient owing to the plasma shielding effect has also been found. The synthesized nanostructured zinc oxide samples have been found useful as efficient laser propellants that can be used in a variety of applications due to diversity in their C_m and specific impulse (I_{sp}) values.

In the third experiment, the refined $Co_{0.5}Zn_{0.5}Fe_2O_4$ is used for the laser ablation micro-thruster. A transparent glass is placed on the plane target for the confinement. The plane target and confined target is compared using (532nm) Nd:YAG laser. The values of C_m of confined ablation propulsion increase significantly as compared to C_m values of the plane target. The effect of doping on the laser propulsion is observed by doping ZnO in the $Co_{0.5}Zn_{0.5}Fe_2O_4$ in different compositions using a fixed fluence of $6x10^5 Jm^{-2}$. The maximum C_m value is obtained on equally doped sample. The surface morphology due to the laser irradiation is also studied.

In the fourth experiment, the single phase $Co_{0.5}Ni_{0.5}Fe_2O_4$ material, as a micro-thruster is used. Three types of pellet targets such as a plane target, a cavity target and a cavity target covered with glass layer are designed to observe the level of thrust via C_m using Nd:YAG 532nm laser. It is observed that the values of C_m increase significantly in cavity target and cavity with glass covered target as compared to plane target.