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Development of a Velocity Interferometer System for Any Reflector (VISAR) system for the study of laser induced shockwaves.

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The irradiation of intense laser beam on the material surface causes it to ablate and as a result, laser induced plasma is formed which causes a high pressure on material surface. Due to this induced high pressure, a shock beam is generated inside the material, which travels all the way to the rear side of the target. These shockwaves have a very short duration of around a few nanoseconds and a high speed of around a few km/s. Study of these waves allows us to investigate the material under extreme condition. These waves are parametrized by the characteristics i.e. wavelength and pulse duration of incident laser pulse and nature of material.To detect and study such kind of waves, a device called Velocity interferometer System for Any Reflector (VISAR) is used. VISAR is based on the principle of Doppler interferometry. The beam incident of the rear surface of moving target retraces it path to VISAR where, using a beam splitter the beam is made to enter the interferometer. Such beam has a doppler shift in the phase. An etalon is used for the generation of known phase difference between two legs of interferometer. The generated delay time of etalon we use is around 0.153ns for 532nm wavelength. This light from two slightly delayed legs of interferometer interferes at the detector . Either a photomultiplier tube (PMT) along with an oscilloscope or a streak camera can serve as a detector. A fringe pattern is recorded which measure the velocity profile of the moving surface. In this regard, Velocity per fringe VPF is the most important quantity to consider. VPF define the sensitivity or resolution of the interferometer. For our case, VPF is in range of km/s. In KAERI, the initially, main laser beam is split into two parts, one for the generation of shockwaves inside the material and other as a probe beam for VISAR. The shock generation is carried out inside the vacuum chamber. The VISAR system is based on the Mach-Zehnder type interferometer in which an unpolarized light is made to fall upon the rear surface of target material returns to the VISAR, is polarized, and passed from two slightly delated legs of interferometer which form an interference pattern. We are considering Aluminum target of a few μm thickness for initial experiment. The design of setup is finalized, and its construction is under progress. First, we will be using 1J, 532 nm wavelength Nd-YAG laser and after its successful completion we will carry out the experiment using 808nm, 30TW Ti:Sapphire laser system. Finally, we plan to use a liquid sheet target and combine the system with ultrafast electron diffraction UED to study solid as well as liquid materials. Doing so will allow us to investigate the behavior of the material (solid or liquid) in response to shockwaves.

References

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