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High-resolution UV relay lens for particle size distribution measurements using holography

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ABSTRACT

Shock waves passing through a metal sample can produce ejecta particulates at a metal-vacuum interface. Holography records particle size distributions by using a high-power, short-pulse laser to freeze particle motion. The sizes of the ejecta particles are recorded using an in-line Fraunhofer holography technique. Because the holographic plate would be destroyed in this energetic environment, a high-resolution lens has been designed to relay the interference fringes to a safe environment. Particle sizes within a 12-mm-diameter, 5-mm-thick volume are recorded on holographic film. To achieve resolution down to 0.5 microns, ultraviolet (UV) light (in this case supplied by a tripled Nd:YAG laser) is needed. The design and assembly of a nine-element lens that achieves >2000 lp/mm resolution and operates at f/0.85 will be described. To set up this lens system, a doublet lens is temporarily attached that enables operation with 532-nm (green) light and 1100 lp/mm resolution. Thus, the setup and alignment is performed with green light, but the dynamic recording is done with UV light. During setup, the 532-nm beam provides enough focus shift to accommodate the placement of a resolution pattern outside the ejecta volume; this resolution pattern does not interfere with the calibrated wires and pegs surrounding the ejecta volume. A television microscope archives images of resolution patterns that prove that the calibration wires, interference filter, holographic plate, and relay lenses are in their correct positions. Part of this lens is under vacuum, at the point where the laser illumination passes through a focus. Alignment and tolerancing of this high-resolution lens will be presented, and resolution variation through the 5-mm depth of field will be discussed.

Keywords: holography, UV optical relay, submicron optical resolution, ejecta, particle size distribution

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