Improved Laser Damage Threshold Performance of Calcium Fluoride Optical Surfaces via Accelerated Neutral Atom Beam (ANAB) Processing

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ABSTRACT

Optics are not keeping up with the pace of laser advancements. The laser industry is rapidly increasing its power capabilities and reducing wavelengths which have exposed the optics as a weak link in lifetime failures for these advanced systems. Nanometer sized surface defects (scratches, pits, bumps and residual particles) on the surface of optics are a significant limiting factor to high end performance. Angstrom level smoothing of materials such as calcium fluoride, spinel, magnesium fluoride, zinc sulfide, LBO and others presents a unique challenge for traditional polishing techniques. Exogenesis Corporation, using its new and proprietary Accelerated Neutral Atom Beam (ANAB) technology, is able to remove nano-scale surface damage and particle contamination leaving many material surfaces with roughness typically around one Angstrom. This surface defect mitigation via ANAB processing can be shown to increase performance properties of high intensity optical materials. This paper describes the ANAB technology and summarizes smoothing results for calcium fluoride laser windows. It further correlates laser damage threshold improvements with the smoothing produced by ANAB surface treatment. All ANAB processing was performed at Exogenesis Corporation using an nAccel100^{TM} Accelerated Particle Beam processing tool. All surface measurement data for the paper was produced via AFM analysis on a Park Model XE70 AFM, and all laser damage testing was performed at Spica Technologies, Inc.

Exogenesis Corporation's ANAB processing technology is a new and unique surface modification technique that has demonstrated to be highly effective at correcting nano-scale surface defects. ANAB is a non-contact vacuum process comprised of an intense beam of accelerated, electrically neutral gas atoms with average energies of a few tens of electron volts. The ANAB process does not apply mechanical forces associated with traditional polishing techniques. ANAB efficiently removes surface contaminants, nano-scale scratches, bumps, particles and other asperities under low energy physical sputtering conditions. ANAB may be used to remove a precisely controlled, uniform thickness of material without any increase of surface roughness, regardless of the total amount of material removed. The ANAB process does not involve the use of slurries or other abrasive polishing compounds and therefore does not require any post process cleaning. ANAB can be integrated as an in-situ surface preparation method for other process steps in the uninterrupted fabrication of optical devices.

Key Words: super-polish technique, accelerated neutral atom beam, ANAB, lateral sputtering, laser damage

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