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High-LIDT Coatings for Laser Applications

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The continuous advancement of high-power laser systems, including those driving inertial confinement fusion experiments, demands optical coatings with exceptionally high laser-induced damage thresholds (LIDT) and precise control over optical and mechanical properties.

This work presents recent developments in the deposition of high-LIDT coatings optimized for pulsed laser applications. Various deposition techniques—ion beam sputtering (IBS), plasma-assisted reactive magnetron sputtering (PARMS), plasma ion-assisted deposition (PIAD), and atomic layer deposition (ALD)—are compared in terms of LIDT, optical performance, and conformality. We discuss the role of optical parameters such as absorption and scattering, as well as the influence of substrate surface quality.

The results indicate that, by tailoring process parameters, it is possible to achieve dielectric coatings with LIDT values exceeding 120 J/cm² (10 ns, 1064 nm) while maintaining excellent environmental stability. These findings pave the way for next-generation optical components in high-energy lasers, CPA systems, precision optics, and ultrafast photonics.

The results also show that short-pulse laser damage mechanisms are strongly influenced by coating defect levels and substrate surface quality. Improving both is therefore essential for increasing the LIDT. While defect levels can be continuously optimized through further development of hardware and process parameters, state-of-the-art surface processing technologies—such as ion beam figuring (IBF)—play an important role in providing high-quality surfaces and will be presented as well.

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