Talbot effect replicative transcription on downstream optics in high-power laser diagnostics system

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In the realm of high-power laser optics, optical grating is largely used for laser energy assessment. For the first time in high-power laser diagnostics system, we have observed that downstream optics often share the same pattern formed by deposited particles that resembles the optical gratings themselves in a high energy laser ablation micro-processing. This type of ablation resulted replica bred-gratings make the eventual diffracted light intensity undergo a significant location and dosage shift at detecting end. After some in-depth reasoning and analysis, we realized this is caused by pattern of ablation on afterwards optic surfaces due to the unique way high-energy laser interact with materials at the meantime under a light-intensity distribution dominated by Talbot effect.

We investigate how the energy distribution of the laser beam, wavelength selectivity, and grating parameters (such as linewidth) altered the way it spread away the ablation surfaces as well as the detecting shifts. In particular, we analyze the diffraction effects produced by the laser beam after passing through the grating and its propagation over its ablated surfaces. Finally, instead of outright focusing on eliminating this ablation effect, we've developed a simple yet effective concept called Talbot Effects Preserving Region (TEPR) help to evade downstream optics away from influence of this transcriptive ablation, by cooperating both Fresnel diffraction theory, electro-magnetic analysis and geometric optic theory. This not only validate our approach but also left a pretty and practical solution to a real pain in the neck which been bugging our tasks for a long time.

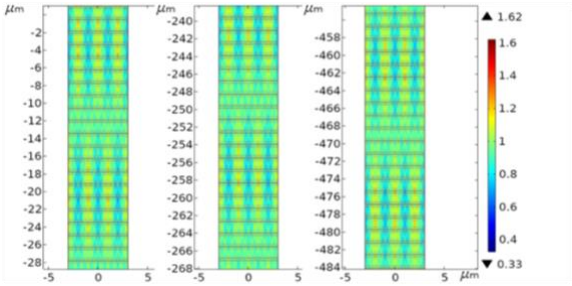

Fig.1 EM theory-derived result along propagation direction modeling intensive and minor region of light intensity

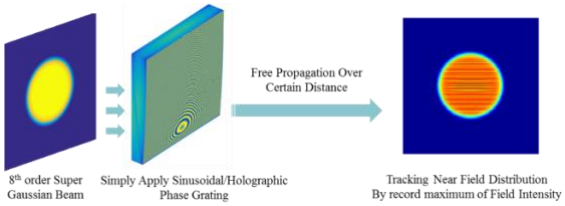

Fig.2 Verification on TEPR by scalar diffraction theory

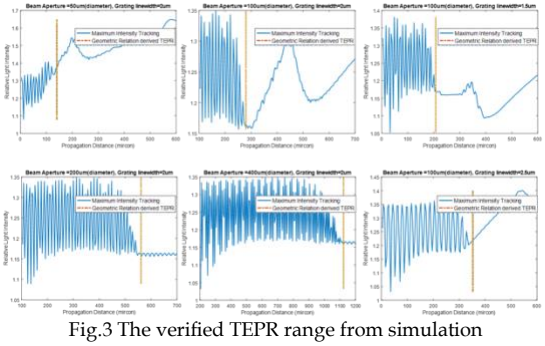

Fig.3 The verified TEPR range from simulation

Acknowledgements: Omitted for brevity.

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