Holographic Exposure System for Patterning Large Gratings with High Wavefront Quality and Uniform Groove Profile

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There are four primary requirements for holographic diffraction gratings used on the OMEGA EP laser:

- Full clear aperture
- 46 cm x 47 cm with edge quality for a |1-3| TGA
- Diffraction efficiency
- >95% efficiency
- Damage resistance
- >2.7 J/cm² @ 10 ps (beam fluence at 62 degrees incident at G4)
- Not demonstrated with full size beam
- Wavefront quality
- Mirror and holographic terms share less than tenth wavefront error
- Uniform holographic exposures are obtained with large-beam laser scanning
- A Nanosurf AFM can access the full aperture using accurate 3-D translation.

Uniform groove duty cycle has been achieved over the full 47-cm aperture:

- A Nanosurf AFM can access the full aperture using accurate 3-D translation.

Holographic optics must have significantly better wavefront than the reflection gratings they produce:

- Mirrors maintain constant OPD over wavelength.
- Phase error decreases at longer wavelength.
- Reflection gratings maintain constant phase error over wavelength for the holographic error term.
- OPD increases by wavelength ratio.

Fabrication Example:

\[ \lambda_{\text{IR}} / \lambda_{\text{UV}} = 10 \] holographic error.

Translating to same currency (λ = 633) yields:

\[ \lambda_{\text{IR}} / \lambda_{\text{UV}} = 10 \] holographic term.

Uniform duty cycle on a photoresist mask leads to uniformly structured SiO₂ pillars.

- Excellent uniformity of gratings has been demonstrated using large-aperture laser-beam scanning.
- Wavefront compensation techniques include a static phase corrector and an adaptive optic module.
- This tool will be used to develop the process of etching, cleaning, and conditioning to achieve a higher resistance to laser-induced damage.