

TECHNOLOGY/BUSINESS OPPORTUNITY

SPECTRAL BEAM COMBINING GRATING OPTIC



Opportunity:

Lawrence Livermore National Laboratory (LLNL), operated by the Lawrence Livermore National Security (LLNS), LLC under contract no. DE-AC52-07NA27344 (Contract 44) with the U.S. Department of Energy (DOE), is offering the opportunity to enter into a collaboration to further develop and commercialize its novel spectral beam combining grating optic technology.

Background:

The increased demand for high-power laser sources with diffraction-limited beam quality has led to significant scaling in output power of laser systems. Attempts at scaling single-output lasers to the 100's of kilowatts has revealed issues with removing waste heat, maintaining beam quality, and avoiding optics damage at the higher powers.

A Spectral Beam Combining (SBC) system that can effectively combine diffraction-limited beams of varying wavelengths into a single beam with broad gain bandwidth provides a straightforward approach to power scaling. Until the development of an extreme-power, ultra-low-loss dispersive grating optics by LLNL, the output power of SBC systems was limited by the ability of the beam combiner to minimize power loss. LLNL's SBC grating optics are precisely designed and fabricated surface-relief grating structures embedded into the topmost layer of a highly reflective, ultra-low loss, multilayer dielectric thin film.

The Diffractive Optics Group of the NIF Directorate at LLNL is the preeminent supplier of large-aperture, high damage-threshold diffraction gratings and other diffractive optics to laser institutions around the world. Presently, the LLNL group is the only supplier of polarization insensitive gratings SBC grating optics. These gratings, designed for polarization independent operation at nominally $1\mu\text{m}$ and with a Littrow out-of-plane (conical) mounting, have been shown to have $>98\%$ diffraction efficiency over $>40\text{ nm}$ bandwidth.

Description:

Livermore Lab's SBC grating optics is the convolution of the following key technologies:

- LLNL proprietary optical coating designs utilizing >100 thin film layers – enables ultra-low-loss, ppm transmission levels through the coating, high diffraction efficiency, and large bandwidth.
- LLNL proprietary dispersive surface relief structure design – perfectly impedance matched to the thin film stack for optimum optical performance.
- Ability to fabricate dispersive surface relief structure and advanced optical thin film coating on superior thermally conductive materials such as silicon and silicon carbide.
- LLNL proprietary processing techniques permitting the fabrication of optimum optical design.

Advantages:

Presently, the LLNL's Diffractive Optics Group is the only supplier of polarization insensitive gratings SBC grating optics. These gratings, designed for polarization independent operation at nominally 1 μ m and with a Littrow out-of-plane (conical) mounting, have been shown to have >98% diffraction efficiency over >40 nm bandwidth.

LLNL's new generation of high-power SBC grating optics has numerous advantages over the current baseline configuration being provided, such as:

- 1) Improved MLD grating mirror stack absorption by over 60X over current configuration, current grating mirror stack ~60 ppm - new grating mirror stack <1 ppm
- 2) Lower mirror stack absorption translates to smaller heating loading and less optics distortion.
- 3) More robust and higher laser damage threshold.

Potential Applications:

Spectral beam combining of lasers or laser emitters.

Development Status:

LLNL demonstrated first hafnia oxide (HfO₂) spectral beam combining (SBC) grating optic with ultra-low absorption and 2.8MW/cm² laser damage performance. Testing showed that the HfO₂ SBC grating optics are 2X less heating when illuminated with 2.8MW/cm² and 6X higher laser damage threshold than the current baseline configuration when contaminated with carbon particles.

LLNL has also filed for patent protection on this invention.

LLNL is seeking industry partners with a demonstrated ability to bring such inventions to the market. Moving critical technology beyond the Laboratory to the commercial world helps our licensees gain a competitive edge in the marketplace. All licensing activities are conducted under policies relating to the strict nondisclosure of company proprietary information.

Please visit the IPO website at <https://ipo.llnl.gov/resources> for more information on working with LLNL and the industrial partnering and technology transfer process.

Note: THIS IS NOT A PROCUREMENT. Companies interested in commercializing LLNL's Spectral Beam Combining Grating Optic technology should provide a written statement of interest, which includes the following:

1. Company Name and address.
2. The name, address, and telephone number of a point of contact.
3. A description of corporate expertise and facilities relevant to commercializing this technology.

Written responses should be directed to:

Lawrence Livermore National Laboratory
Innovation and Partnerships Office
P.O. Box 808, L-795
Livermore, CA 94551-0808
Attention: FBO 429-19

Please provide your written statement within thirty (30) days from the date this announcement is published to ensure consideration of your interest in LLNL's Spectral Beam Combining Grating Optic technology.