

## PRESS RELEASE

### Grating manufacture at Helmholtz-Zentrum Berlin scores breakthrough - Sawtooth gratings for photon sources are once again available

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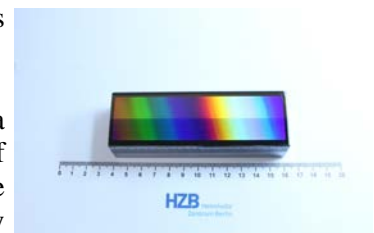
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The Technology Center for Optical Precision Gratings at the Helmholtz-Zentrum Berlin (HZB) has scored a breakthrough in the manufacture of these optical building elements. Gratings are used in photon sources to diffract light and filter out those wavelengths that are needed for a given experiment. Now, after two and a half years of work, for the first time ever, the developers have created high precision sawtooth gratings that meet the demands of scientific experimentation. These sawtooth (or blazed) gratings recently underwent testing at BESSY II, the HZB's own electron storage ring. The result: The gratings' behavior conformed to the researchers' theoretical predictions. The HZB Technology Center is the World's sole manufacturer of high efficiency precision gratings for use in photon sources. The project has received EU funding in the form of an EFRE grant.

Sawtooth gratings consist of a silicon substrate to which an ultrathin layer of gold is added using vapor deposition. To ensure the grating is able to diffract light, a diamond is used to etch small grooves into the grating, creating a structure that – when viewed under the microscope – resembles an assembly of tiny sawteeth. 600 such teeth per millimeter were etched into the grating – and temperatures during this process are allowed to fluctuate no more than 0.02 degrees Kelvin. To ensure the gratings allow for the passage of a maximum amount of light of the proper wavelength, the sawteeth have to be flat. This is done by treating the etched grating's gold film using ion etching equipment so the tilt of the sawteeth is flattened out. The HZB developers successfully decreased the angle to a mere 2 degrees.

“To produce these sawtooth gratings, we had to quickly pick up and master a host of technological processes,” explains physicist Dr. Friedmar Senf, one of the HZB scientists working on the EFRE project. Since there really is no one else in the World working on this stuff, they weren't able to draw on any existing expertise. The former manufacturer of these types of gratings, the company ZEISS, had ceased production of high precision gratings back in 2008. Since then, no new photon source gratings have been produced anywhere. The researchers are hopeful that their latest success will soon help close that gap. “The demand for gratings is very high – and we already have a long list of orders,” says Senf.

The Technology Center team wasn't able to actually start development until early 2013. In the two years prior, the HZB's lab facilities had to be set up and the ZEISS equipment and machines refurbished. “It took a long time before our ruling machine was once again operational to perform this highly precise kind of work. One of the things we did was completely replace the electrical wiring. We're all the happier that we managed to create functional gratings in a relatively short amount of time,” says Senf. The team also develops additional novel kinds of gratings including toroidal gratings on curved substrate surfaces, variable line density gratings, and reflective zone tiles for use in free electron lasers.



HZB manufactured sawtooth grating.

Picture: HZB



This machine is used to create the sawteeth. A diamond is used to etch tiny grooves into gold coated silicon substrates.

Picture: HZB

Friedmar Senf, Bernd Loechel, and Alexei Erko are all co-directors of the HZB Technology Center for Optical Precision Gratings. One of the Center's supporters and partners is the Bad Münstereifel based company DIOS.

The Technology Center is located at the Institute of Nanometer Optics and Technology, which brings together years of experience in the design, manufacture, and metrology of high quality optics. It is important for BESSY II's appeal to be leading the way in X-ray optics development.

The **Helmholtz-Zentrum Berlin für Materialien und Energie (HZB)** operates and develops large scale facilities for research with photons (synchrotron beams) and neutrons. The experimental facilities, some of which are unique, are used annually by more than 2,500 guest researchers from universities and other research organisations worldwide. Above all, HZB is known for the unique sample environments that can be created (high magnetic fields, low temperatures). HZB conducts materials research on themes that especially benefit from and are suited to large scale facilities. Research topics include magnetic materials and functional materials. In the research focus area of solar energy, the development of thin film solar cells is a priority, whilst chemical fuels from sunlight are also a vital research theme. HZB has approx.1,100 employees of whom some 800 work on the Lise-Meitner Campus in Wannsee and 300 on the Wilhelm-Conrad-Röntgen Campus in Adlershof.

HZB is a member of the Helmholtz Association of German Research Centres, the largest scientific organisation in Germany.