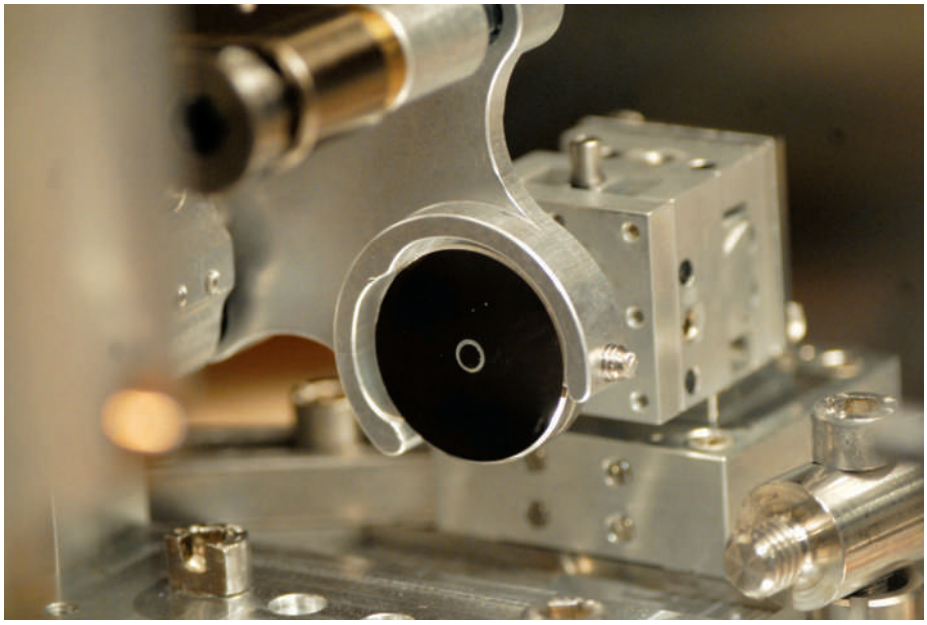
Optics made to measure

Researchers in Germany have set up a company to manufacture custom-made optics for ultrafast applications. **Nadya Anscombe** finds out about the company's products and its plans for the future.

There is something unique about the start-up company UltraFast Innovations. The company, which designs and manufactures tailor-made optics for ultrafast applications, was set up by two academic giants in the field of ultrafast optics research — the Ludwig Maximilian University (LMU) of Munich and the Max Planck Institute of Quantum Optics (MPQ), both based in Garching, Germany. These organizations have both spun-out companies before, but this one is different — this one they own. Unlike other spin-offs, where researchers set up their own company and licence technology from their university or institute for a small stake in the company, UltraFast Innovations is owned 50:50 by LMU and MPQ.

Why have these organizations decided on this business strategy for the first time? The answer lies in one of the motivations for setting up the company. Like many universities and institutes, the LMU and the MPQ have some very expensive infrastructure such as manufacturing equipment, clean rooms and characterization equipment (see Box 1). Although this equipment is essential to researchers, it is often standing idle and therefore not used to its full potential as it would be in, for example, full-scale manufacturing. UltraFast Innovations was set up to utilize this extra capacity and make the most of the world-class facilities in Garching.

This was, of course, not the only motivation for starting the company, which was set up in July 2009. Researchers in Garching, particularly from the groups of Ferenc Krausz and Ulf Kleineberg, have known for some time that there is a market for the types of optical components they develop. The groups have a long history of research in ultrafast photonics and have built up considerable expertise in manufacturing ultrafast optics such as chirped mirrors and metallic multilayer mirrors. These are all essential components in ultrafast laser systems, and the groups found themselves inundated with requests for these components — many of which they could not fulfil. "UltraFast Innovations was set up to give everyone access to our technology and know-how," says Jens Rauschenberger, CEO of the young firm.



ULTRAFAST INNOVATIONS

Detail of the extreme-ultraviolet/infrared delay unit available from UltraFast Innovations. This component has allowed generation of 80-attosecond pulses — the world's shortest-duration light pulses .

The company supplies optics that are at the limits of what is possible in terms of design, manufacturing and performance.

> "Many of our customers are researchers just like us, so we understand their needs very well."

Its products cover ultraviolet, visible and infrared wavelengths all the way to the extreme-ultraviolet and soft-X-ray range. It specializes in the design and manufacturing of optical elements tailor-made for ultrafast laser applications. "We have the capability to design and manufacture dielectric optics for laser applications, as well as metallic multilayer structures for X-ray applications," says Rauschenberger. He believes that being rooted in the research environment gives the company a unique selling point. "Many of our customers are researchers just like us, so we understand their needs very well," he says. "We can immediately incorporate the latest research results into our designs and can also test the products in real laser systems."

The company certainly has good pedigree. Krausz and his colleagues were the pioneers of chirped mirror technology and attosecond pulse generation, and currently hold the record for the shortest light pulses ever created (80 attoseconds).

"It is the specialized optics we developed that make advances such as this possible," says Rauschenberger. "And it is not just scientific researchers who need our products. We have seen considerable demand from industry; industrial clients now make up about half of our customer base."

For example, UltraFast Innovations' highly dispersive mirrors are allowing manufacturers of femtosecond lasers to replace prism compressor units with all-dispersive-mirror compressor units. These all-mirror compressors offer distinct advantages over incumbent technology: by precisely tuning higher-order dispersion, amplified pulses with durations close to

Box 1 | Manufacturing equipment

UltraFast Innovations has three different coating facilities at its disposal.

Magnetron sputtering system

This system is equipped with two magnetrons and a plasma source, providing plasma- or ion-assisted reactive dual-magnetron sputtering. Owing to the high deposition rates, the system has short process times even for complex multilayer systems. The coating films produced have higher refractive indices than those achievable with electron-beam evaporation, which indicates very dense layers. The system covers the spectral range of 250–3,000 nm and can coat substrate diameters of up to 100 mm.

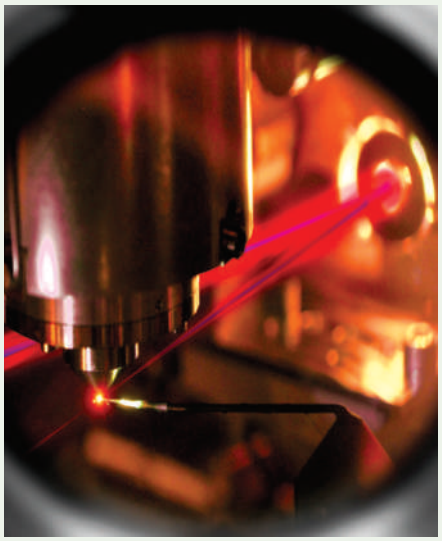
Electron-beam evaporation system

Electron-beam evaporation is mainly used for non-dispersive coatings. The company's electron-beam system has a new process control that features maximum automation and can handle large-scale optics with diameters of up to 265 mm and thicknesses of up to 65 mm. It can be used for the spectral range of 200 nm to 10 μm.

Ion-beam deposition system

The dual-ion-beam deposition system is equipped with two inductively coupled ion beam plasma sources; one is directed onto the target to ablate the target materials, and the other is directed onto the substrate for optional ion-beam-assisted deposition. The possibility of *in situ* spectral ellipsometry in the near-infrared to ultraviolet region allows subnanometre process control during deposition. Ion-beam deposition is known to produce very dense and smooth layers in a very stable process. The ultrahigh background vacuum pressure of 10^{-8} torr also ensures clean layers. The system is operated in a class-1,000 clean room.

"For our coatings we only use the best substrates available on the market," says Rauschenberger. "Up to 2-angstrom root-mean-square surface roughness, $\lambda/20$ surface form and 10^{-5} surface quality is attainable in many different shapes, sizes and radii of curvature."



ULTRAFAST INNOVATIONS

UltraFast Innovations has unique access to state-of-the-art manufacturing equipment at the Ludwig Maximilian University of Munich and the Max Planck Institute of Quantum Optics, both of which are based in Garching, Germany.

the Fourier limit can be achieved. This new compressor technology is significantly smaller and yields higher transmission than prism compressor units, resulting in increased output power. The all-chirped mirror pulse compressor also eases alignment issues, which is beneficial for the reliable operation of amplifier systems. "For us, the market potential in this area is big," says Rauschenberger. "It is obvious that the product works well and offers many advantages, so we believe that in the future all femtosecond lasers will feature all-dispersive-mirror compressor units."

As well as highly dispersive mirrors, the company also offers a variety of mirrors including ultrabroadband dispersive mirrors, ultrahigh-reflectivity mirrors, third-order dispersion mirrors and multilayer extreme-ultraviolet mirrors with controlled dispersion. The company can also custom-design any mirror and coating according to customer specifications.

After only eight months of trading, the company has already observed a trend in customer needs. "We have noticed that customers are interested in a higher degree of integration, rather than just individual components," says Rauschenberger. This is why the company offers products such as its all-dispersive-mirror compressor units, as well as extreme-ultraviolet/infrared pulse delay units for pump–probe experiments and beamline vacuum assemblies for high-harmonic generation and spectroscopy. These integrated optical systems provide an even greater benefit for the customer than mere optical components because they are based on extensive knowledge and expertise. "We can directly build on our expertise as researchers and thus save scientists in research groups and industry all over the world a lot of time and money when setting up their experiments," says Rauschenberger. This is a direction in which the new company sees great potential, and it is planning to expand its product line by introducing, for example, specialized autocorrelators and laser sources.

ULTRAFAST INNOVATIONS

UltraFast Innovations was founded by researchers who have a long history of research in ultrafast photonics and have built up considerable expertise in manufacturing ultrafast optics such as chirped mirrors (pictured) and metallic multilayer mirrors.

Rauschenberger is confident about the future. "I can see growth in many areas," he says. "We can now handle more orders, as well as larger orders. We have lots of ideas for new products that would fit well into our product range, and we also want to grow our customer base. This will hopefully allow us to expand the number of employees we have."

When asked about the long-term future of the company, Rauschenberger points out that the company is only eight months old and that it is therefore too early to speculate. "And anyway, there is no precedent that I can use as an example," he says. "This is the first time the LMU and the MPQ have set up a company such as this, and it remains to be seen how the company will evolve. So far, the market reaction has been really positive." ❐

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