Microstructures embedded in materials using combined laser and plasma beams

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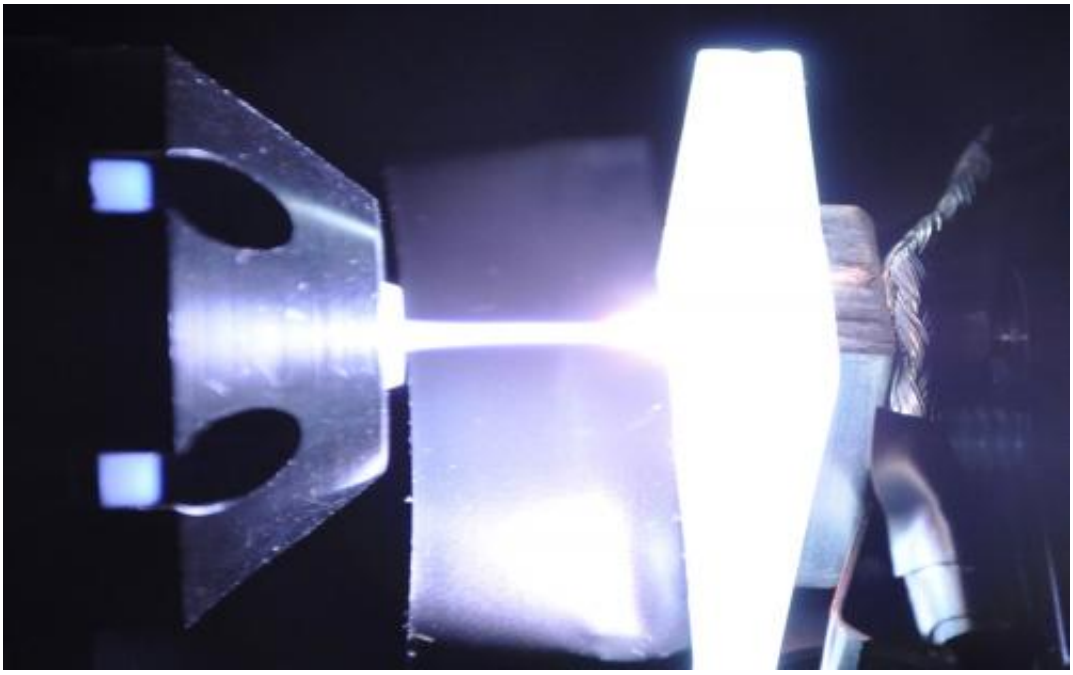

Fraunhofer researchers combine a laser and a plasma beam for the first time to realize microstructures to glass objects. Initial results reveal that by this approach, the production process can become more precise and economical. Credit: Fraunhofer IST

Miniscule microstructures can be embedded in materials with laser beams. But a lot of energy is needed for this when it comes to transparent materials like glass. So, researchers sought out a more efficient solution: they combined the laser with a plasma beam.

You can find them in cellphones, in high-quality cameras and electronic driver assistance systems: tiny optical components, made of glass, that are equipped with microstructures. As a rule, laser technology is used to insert the extremely fine structures into the glass surface. Since glass is transparent, however, laser processing becomes a real challenge: if the laser's energy density is too low, then insufficient radiation is absorbed in order to achieve the desired effect. If the power density is excessive, then undesired side effects often result – like contamination by ablation debris.

Researchers at the Fraunhofer Institute for Surface Engineering and Thin Films IST are now striking out on a completely new path: in the structuring process, they couple atmospheric pressure plasma into the laser beam. "By using this laser-plasma hybrid technology, we have succeeded in conducting the structuring using far less energy," explains Prof. Wolfgang Viöl, head of the Application Center for Plasma and Photonics at IST in Göttingen.

Plasma is known to be a reactive gas that consists of free-moving, energy-rich electrons, ions and neutral particles. If the pressure in this gas mixture roughly corresponds to that of the surrounding environment, then this reflects atmospheric pressure or normal pressure plasma. In nature, plasma appears in lightning bolts, for example. Plasma is often used today in the machining of components – to refine or to modify surfaces.

Hybrid technology for precise processing results

The combination with laser technology is new: in order to realize this process, scientists have designed a plasma source that initially delivers cold plasma, and secondly produces a very fine beam that can be coupled into the laser beam without any complications. "The effect of this plasma beam is that the laser radiation can be absorbed better, so that we

can conduct the processing with relatively low laser energy," explains Prof. Viöl. The standard procedure today calls for the use of either a UV or an infrared laser for glass processing, so that the necessary absorption is achieved. Both procedures, however, have disadvantages: whereas infrared lasers are really imprecise, the operating costs with UV lasers are exorbitant. By contrast the laser/plasma hybrid technology delivers not only precise processing results, it is also economically attractive.

This new procedure had already proven itself in tests with various glasses, and a patent application has just been submitted for it. The spectrum of applications is vast: microoptics made of glass are needed in telecommunications as much as in consumer electronics or security technology. Tiny microstructures in glasses that are not visible to the naked eye can furthermore be used as protection against plagiarism for high-grade optical components.

The researchers will exhibit a few glass prototypes that were structured with the new procedure, as well as a plasma source which can be used for processing, at this year's Optatec, the international trade show for optical technology, which takes place from May 20 to 22 in Frankfurt (Hall 3, Booth D50).

At the next stage, the Göttingen-based scientists will also extend their hybrid approach to other materials – such as metals, ceramics or synthetics. The simultaneous use of laser and plasma could also make new processing or coating processes possible – even for temperature-sensitive materials such as textiles and paper.

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materials-combined-laser.html