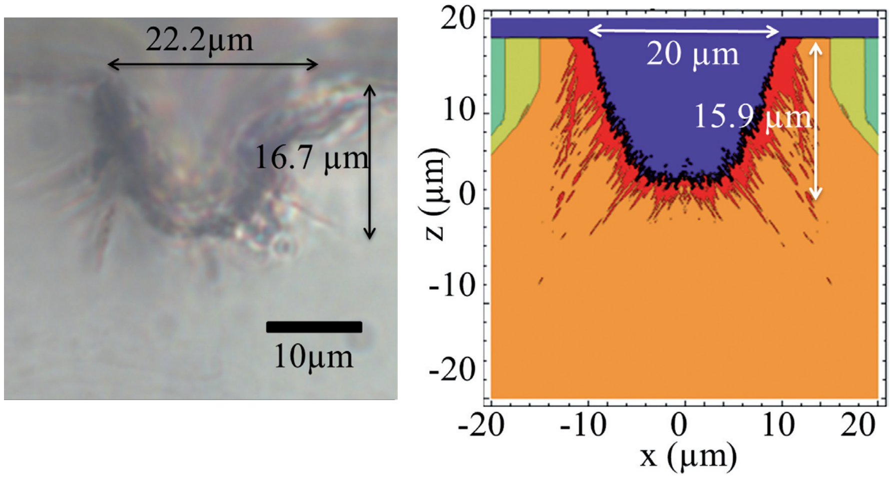

3

MODELING AND SIMULATION OF THE ABLATION OF GLASS

Task

The sharp increase in demand for smartphones and other flat-panel displays has given rise to substantial market potential for the processing of transparent dielectric materials (e.g. glass) using ultrashort pulsed laser radiation. However, the mechanisms relating to ablation and material damage when using the laser are still barely understood.

Method

The aim of modeling is to provide a spatially resolved description of the beam propagation and energy deposition as well as the damage or ablation of dielectric materials when using ultrashort, high-intensity laser pulses. To this end, the dynamics of the electronic system are illustrated, the effect on the propagating radiation field calculated, and the ablated volume and the damage in the material volume determined based on these findings.

Result

A model that includes the subprocesses of nonlinear absorption, radiation propagation and ablation was implemented, and tested by means of comparison with real cuts in glass. The comparison shows a perfect match between the simulation's prediction and the experimentally determined micrograph. Not only is the ablation geometry demonstrated very precisely, the material damage inside the glass volume (average damage depth [black on the micrograph, red in the simulation], peak-shaped damage structures, etc.) is also illustrated correctly. This damage in particular is extremely interesting for assessing the breaking strength of the final component and can now be reliably predicted.

Applications

The implemented model can be applied to any material that absorbs incident radiation through nonlinear processes such as multiphoton or cascade ionization. Such materials include glass, aqueous solutions or biological tissues. The developed methodology can also be applied to other dielectric materials and even semiconductor materials used in the solar and electronics industries.

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3 Micrograph / simulation after 5 pulses.