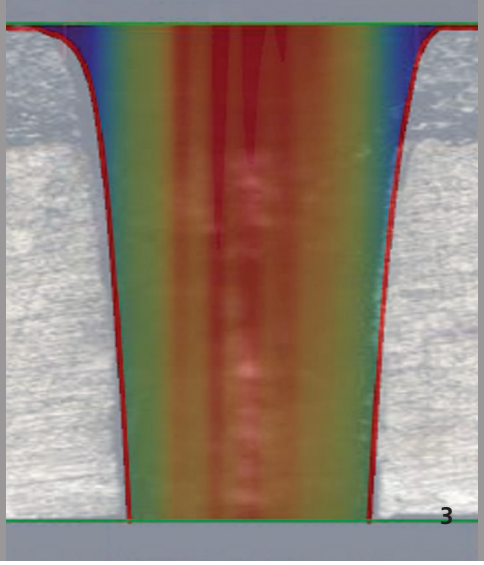

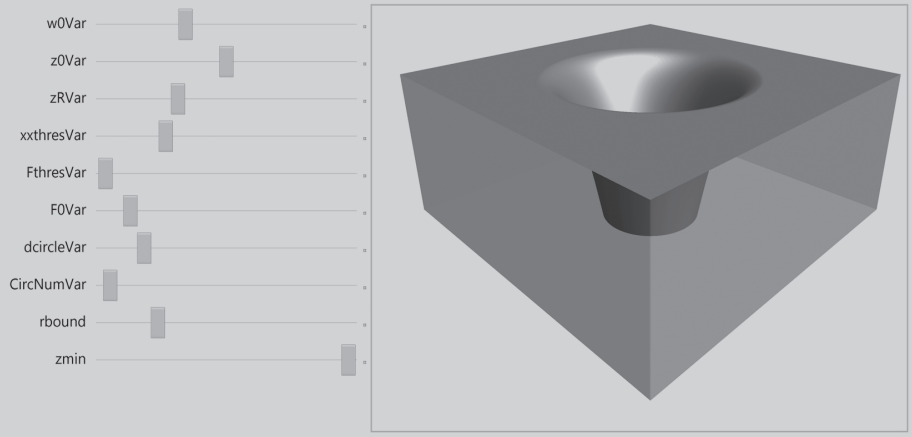

MODELING AND SIMULATION OF DRILLING WITH LASER RADIATION

Task

When holes are generated with long pulsed laser radiation, it can be demonstrated that the ablation shape that is formed initially approaches, at the borderline of many pulses, a so-called asymptotic shape such that it changes only slightly or not at all with irradiation by further pulses. These findings are already known from the USP ablation of dielectric and semiconducting materials. Moreover, they have been explained by Fraunhofer ILT with the projected intensity falling below the intensity threshold.

Method

Modeling and simulation aims to describe and predict the final, i.e. asymptotically arising hole contour, or the hole shape, that no longer changes when further irradiation is applied. Moreover, the task of modeling is to identify and explain the cause or the mechanism that leads to such asymptotics in the shape of the drill hole. This explanation cannot be extracted from the experimental findings simply by plain examination.

Result

The explanation for the occurrence of an asymptotic shape of the hole was identified, its underlying mechanism numerically implemented, tested and clearly confirmed by comparison with experimental data (see Figure 3). There now is an interactive numerical tool that can illustrate the impact of changes in process parameters on the shape of the hole in real time (see Figure 4).

Applications

Originally, the basis for the consideration of an asymptotic hole shape comes from findings on USP ablation, in which an asymptotic ablation contour occurs in the same way (as described above) and was observed first. This principle now proves valid even for the removal with long pulses, a fact suggesting that the same or similar principles can be applied to many other laser manufacturing processes.

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3 Overlay of simulated hole contour, exp. observation and the real beam distribution used.

4 Developed interactive tool for predicting asymptotic hole shapes.