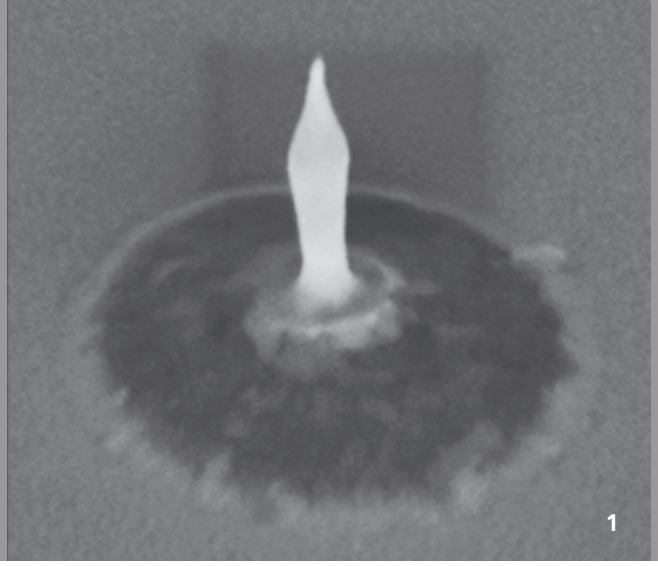

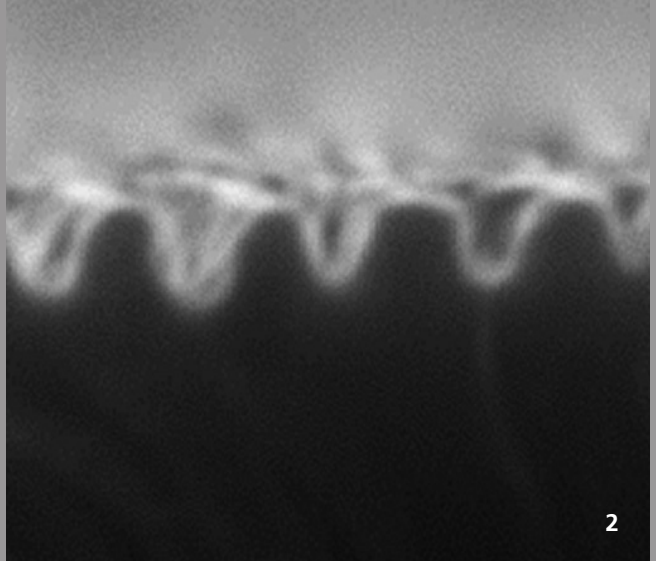

LASER-INDUCED NANO-STRUCTURES FOR NEAR-FIELD OPTICAL APPLICATIONS

Task

Highly sensitive spectroscopy methods are increasingly being used to detect very low concentrations of compounds such as explosives, narcotics or toxins. The sensitivity of this method may be increased to a few ppm (parts per million) when near-field amplifying substrates are employed. The reinforcing effect of the substrates is caused by structural field increases of appropriate micro- and nanostructures. So that the sensitivity can be increased, the natural resonances of the structures must be adapted to the compound to be analyzed. In a DFG project, relevant interaction processes for the development dynamics have been examined in detail, thereby making it possible to generate laser-induced nanostructures in a reproducible and tailor-made fashion.

Method

When a gold thin film is irradiated with an ultrashort laser pulse, gold antennas can be produced (Figure 1). In the irradiated thin gold film, a stress-based melt pool dynamic is induced, which results in a material ejection in the center of the irradiated region. Due to the high cooling rates of the thin film, the expelled material solidifies in the form of a jet. During the structuring of semiconductors, the large intensity of the ultrashort laser pulses used enables the excitation of electromagnetic surface waves. The interference of these waves with the incident laser radiation on the surface leads to periodic ripple structures (Figure 2) with a parameter-dependent period in the sub 100 nm range.

Result

Based on the experimental data, model-based theoretic approaches have been developed that describe the causal processes of the respective formation dynamics. Arising from these developments are structure sizes, dependent upon the process parameters, which allow nanostructures to be generated for customized applications and have a precision in the range of some 10 nm.

Applications

The near-field amplifying effect of micro- and nanostructures is increasingly being used in the fields of analytical chemistry, biology and security technology. Furthermore, ripple structures can be used to increase the absorption of semiconductors in photovoltaic applications.

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1 Gold nanojet.

2 Cross-section of a corrugated surface.

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