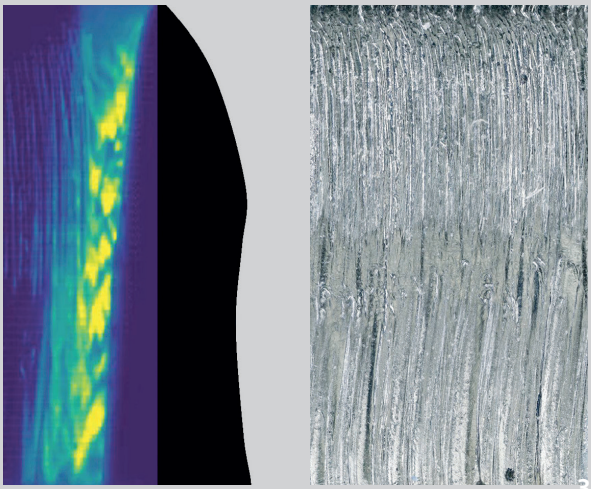

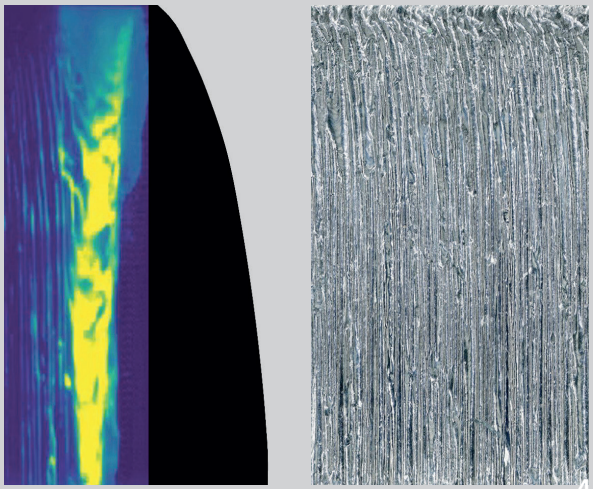

IN-SITU VISUALIZATION OF MULTIPLE REFLECTIONS DURING LASER BEAM CUTTING

Task

During laser beam cutting, instabilities of the laser cutting front cause an unwanted loss of quality, which appears in the form of ablation and solidification striations and can lead to dross formation. The effects of multiple reflections of the laser radiation in the kerf and their effects on the cutting result are still not fully understood.

Method

Thanks to a trim-cut procedure, the melting and solidification dynamics during laser beam fusion cutting can be diagnosed in-situ, which makes it possible to access and, thus, observe the kerf. In such trimming cuts, cutting is done along an existing rectilinear workpiece flank with defined laser beam overlap. So that a guided supersonic gas jet can be maintained along the melt film, the missing cut edge is simulated by a transparent replacement flank. The variations of laser-beam overlap and distance between the replacement edge and workpiece flank allow the amount of multiple reflections to be manipulated.

Results

For the first time, the trim-cut procedure has proven that there are multiple reflections in the cutting kerf. The existence of these reflections has been clearly demonstrated, thus having the following consequences:

- The molten area from the cutting to the solidification front on the cutting edge is significantly enlarged over the area that is illuminated directly by the laser radiation.
- Multiple reflections have a significant influence on the striation pattern and the horizontal structure of the forming cutting edge.
- The ablation rate is increased and thus multiple reflections increase the process efficiency.

Applications

The detection of multiple reflections is an important step in developing adapted process parameters to increase the cutting edge quality while avoiding dross formation.

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3 Pruning incision, cutting flank profile and associated cutting flank (in each case from left to right) with multiple reflections.

4 ... and without multiple reflections.