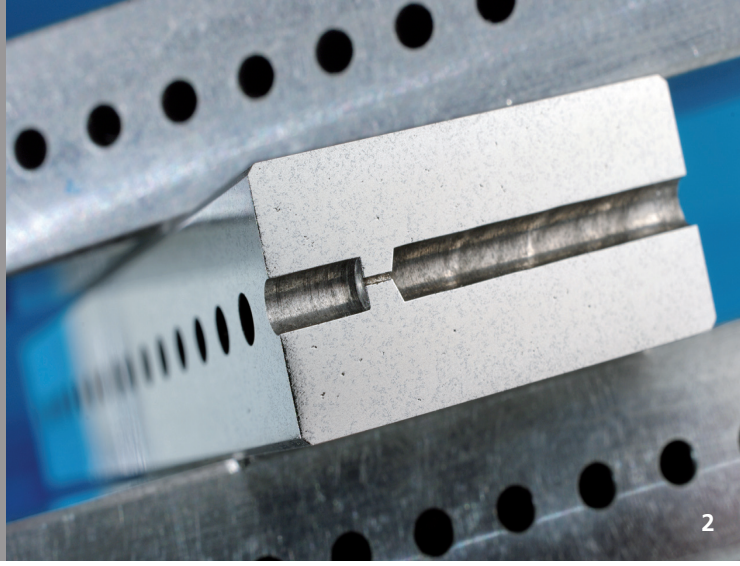

LASER BEAM DRILLING OF HIGH-PRESSURE JET NOZZLES

Task

At present, mobile automotive air conditioning systems contain refrigerants with certain properties that are harmful to the environment and health. The natural refrigerant CO_2 provides one long-term alternative; it is available cost-effectively in virtually unlimited quantities as a technical byproduct. Owing to the large pressure ratios required of up to 300 bar, the control unit needs to be redesigned. The nozzle hole with a diameter of 300 µm cannot be manufactured mechanically because of the inhomogeneous microstructure of the lightweight material used, AlSi17Cu4Mg, and the technical requirements placed on the hole geometry. The laser beam drilling process has the potential to become a suitable alternative.

Method

In order to meet the requisite specifications in terms of geometrical and metallurgical quality, tests with short- and ultrashort-pulsed laser radiation are being conducted (pulse durations in the µs to ps region). The experimental testing is based on the design of experiments (DOE), ensuring a minimal testing overhead.

Result

The use of ultrashort-pulsed laser radiation allows the following geometrical and metallurgical properties of the nozzle holes to be achieved:

- Diameter tolerance ± 5 µm
- Conicity < 10 percent
- Recast layer thickness < 10 µm
- Surface roughness R_a < 5 µm
- Prevention of molten adherent dross at the hole entry and exit

Applications

In light of the expected legal ban on currently used refrigerants, some of which are hazardous, in mobile air conditioning systems, the newly developed control unit for CO_2-operated air conditioning systems provides a suitable alternative. The laser drilling process step can be integrated in an automated production facility.

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1 Laser beam drilling.

2 Longitudinal section of a nozzle hole.

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