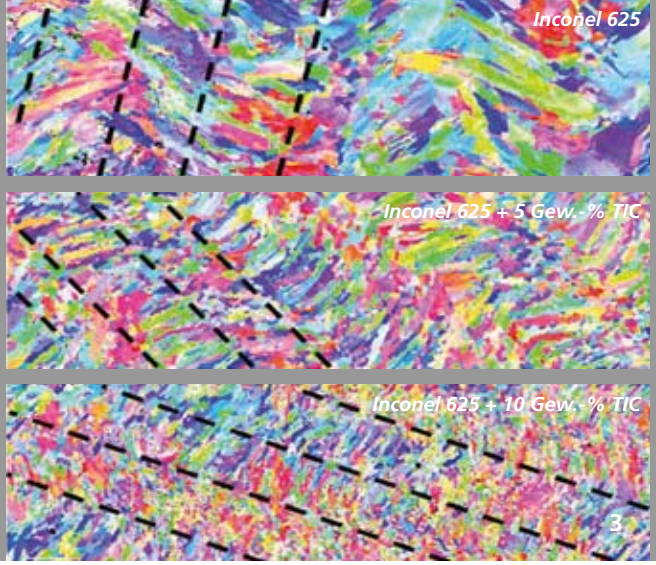

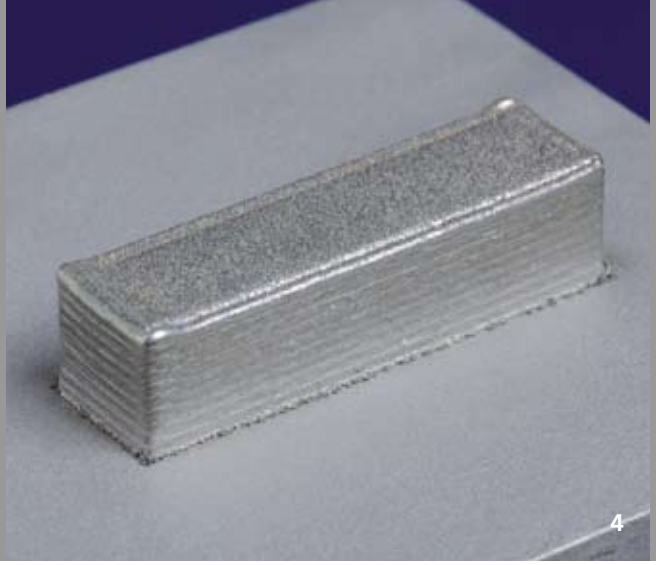

LASER METAL DEPOSITION OF MICRO-PARTICULATE METAL-MATRIX COMPOSITE MATERIALS

Task

Micro-particulate additives from ceramic hard material phases in a metal matrix can contribute to reducing abrasive and adhesive wear as well as to improving static mechanical strength properties. These additives can significantly improve such properties in nickel-based alloys, e.g. Inconel 625, which are commonly used at operating temperatures > 400 °C. Decisive for the properties of particulate-reinforced composite materials is a homogeneous distribution in the matrix material and an exact spatial and temporal control of the energy input and additives. These requirements can be fulfilled by Laser Metal Deposition.

Method

To investigate to which extent the percentage of TiC particles in the micron range within the metal matrix of Inconel 625 (IN 625) influences the mechanical properties, powder mixtures with different TiC contents (2.5, 5, 10 weight percent) were first produced by mechanical alloying. Tensile test samples were cladded with the process parameters adapted to the TiC percentages and then underwent a metallographic examination. Subsequently, the tensile test samples were tested at room temperature and at 600 °C.

Result

An increasing percentage of TiC in the IN 625 matrix leads to an increase of hardness, up to 410 HV 0.3 at 10 weight percent TiC (260 HV 0.3 without TiC additives). The elastic limit Rp 0.2 increases in the same interval from approx. 660 Mpa to approx. 940 Mpa. The maximum tensile strength Rm is reached with 10 weight percent TiC and amounts to 1270 MPa; at the same time, with increasing TiC percentage, a grain refinement of the micro-structure could be identified (cf. Figure 3). The effect of grain refinement also remains at an operating temperature of 600 °C. The elongation at fracture tends to fall as the TiC percentage rises. The samples with 10 weight percent titanium carbide exhibit a significantly reduced elongation at fracture of 3 percent.

Applications

Particulate-reinforced metal-matrix composite materials can be used in the aerospace industry as well as in the energy sector for repairing and manufacturing heavy-duty components that have to withstand high operating temperatures. For example, in turbine components, the strength, the wear resistance and the creep resistance can be improved with these materials.

The work presented here was funded within the scope of the Sino-German Research Project »nPR MMC by LMD«.

Contact

M.Sc. Chen Hong
Telephone +49 241 8906-8025
chen.hong@ilt.fraunhofer.de

Dr. Andres Gasser
Telephone +49 241 8906-209
andres.gasser@ilt.fraunhofer.de

3 EBSD images from microstructures of IN 625 with differing TiC percentages.

4 3D volumes for tensile test samples.