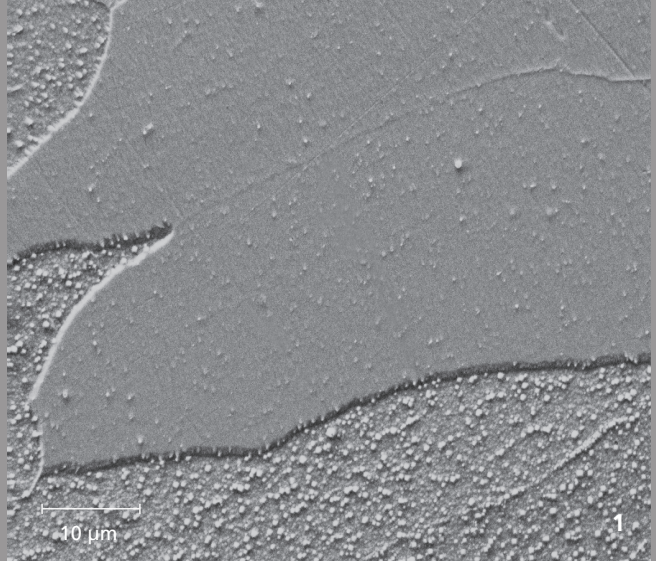

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ADDITIVE MANUFACTURE OF NANOPARTICULAR-REINFORCED MATERIALS

Task

Nanoparticle-reinforced alloys are composite materials that consist of nanoscale, ceramic particles embedded in a metallic matrix. Since the ceramic particles are distributed homogeneously, this class of materials offers not only high strength and excellent creep resistance in the high-temperature environments, but also increased resistance to high-energy neutron radiation in nuclear reactors. In cooperation with the Max-Planck-Institut für Eisenforschung (MPIE), Fraunhofer ILT is developing the process technology using the additive manufacturing processes laser material deposition (LMD) and laser powder bed fusion (LPBF) as an alternative to the conventional powder-based metallurgical production route.

Method

On the basis of a steel alloy, the partners have developed a process chain using LMD and LBPF; the chain consists of a short grinding process for producing a powder composite of metallic and ceramic powder materials (for example, Y_2O_3, starting size approx. 45 nm) and of a subsequent final consolidation via laser based additive manufacturing.

Results

The process times for producing a powder composite with a grinding process were significantly reduced so that a powder material suitable for additive manufacturing processes could be produced. LMD was used to produce dense bodies with homogeneously dispersed ceramic particles with diameters from 50 to 150 nm. The enlargement of the particles is caused by agglomeration, yet materials strength in the high temperature regime increases significantly. In LPBF, particles of a few nanometers in size are also found in a homogeneous distribution so that increased radiation resistance is to be expected in addition to a further increase in materials strength.

Applications

The field of application lies primarily in nuclear technology, for increasing radiation resistance, but also in turbomachinery, for enhancing the creep strength of turbine blades along with good corrosion resistance.

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1 Finely dispersed Y_2O_3-based nanoparticles in a steel matrix after consolidation by LMD, source: ACCESS e.V..