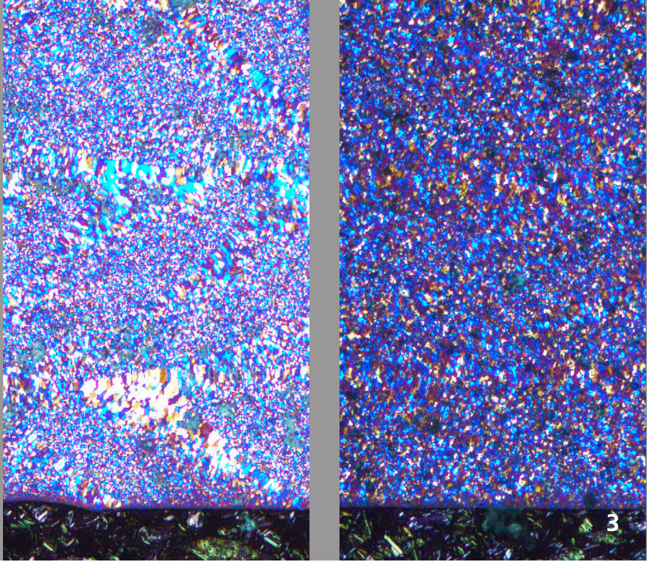

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LASER MATERIAL DEPOSITION OF AL-MG-SC-ZR ALLOYS MODIFIED WITH NANOPARTICLES

Task

Al-Mg-Sc-Zr alloys are well suited for additive manufacturing (AM) technologies with their inherent high cooling rates because they have grain refining and precipitation hardening properties. However, the scope of these alloys is limited because the cost of scandium is so high. To lower the price, an aluminum matrix composite can be produced by adding ceramic nanoparticles to reduce the Sc content. In the place of scandium, the nanoparticles should serve both as nuclei for the aluminum matrix structure and hinder the movement of the lattice dislocations. A sub-target of this research is to produce a modified composite powder with a suitable process capability for laser material deposition.

Method

Fraunhofer ILT prepared a composite powder of TiC nanoparticles and an Al-Mg-Sc-Zr alloy (AA5024) having an Sc content of 0.4 wt% by mechanical alloying while varying the addition amount of the nanoparticles and the mechanical alloying time in a ball mill . Evaluation criteria for the powder are sphericity, particle size and nanoparticle distribution in the powder mixture. Volume built-ups were produced by laser material deposition to develop suitable process windows for defect-free processing.

Results

When the amount of nanoparticles and the mechanical alloying time are varied, suitable composite powders for laser material deposition can be produced. Volume build-ups with a density of more than 99.8 percent could be manufactured by adjusting the process parameters. The uneven grain structure within the solidified melt pool, which is typical for the additive production of Al-Mg-Sc-Zr alloys, could be clearly homogenized by the addition of nanoparticulate TiC during laser material deposition.

Applications

Laser material deposition can be used to additively manufacture samples, defect-free, out of Al-Mg-Sc-Zr alloys with TiC nanoparticles. Future application areas for AM are to be seen where complex lightweight design must be combined with high mechanical strength, such as in aerospace and automotive engineering.

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3 Grain structure of the samples without (left) and with TiC (right).

4 Solid body out of AA5024 without (left) and with TiC (right).