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Polymer Nanocomposite Powders for Laser Additive Manufacturing

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Selective laser sintering (SLS) allows the generation of three dimensional components with complex geometries layer by layer from semi-crystalline thermoplastic powders. Here, a CO_2 laser uses its energy to transfer the solid powder microparticles into their molten, viscous state allowing the coalescence to a homogeneous film. During the building process it is important that the temperature is held right before the melting temperature and above the crystallization temperature to avoid deviations in the final part dimensions. One approach to adjust this process window and to increase the laser energy absorption is to adhere carbon black nanoparticles to the powder microparticles. Carbon black enhances the absorption behavior due to its high absorption coefficient, while in the form of nanoparticles they act as heterogeneous nucleation seeds, influencing the melting and resolidification behavior during the process [1, 2]. Even though nanoparticles with weight fractions of ≤ 0.1 wt% leave the process parameters unchanged, they heavily affect the formation of crystalline structures during cooling (Fig. 1) [3, 4]. Therefore, a high dispersion of nanoparticles with low filling factors is essential for optimal material processability and precise final part dimensions [3, 5]. A novel laser based approach allows the surfactant-free synthesis of colloidal nanoparticles in an aqueous solution and their well dispersed and homogeneously distributed adsorption onto the microparticle surface [5]. To investigate the influence of added nanoparticles on the material behavior during the process, commercially available PA 12 powders with adsorbed carbon black nanoparticles (≤ 0.1 wt%) through various methods will be analyzed on their thermal and optical properties. The gained fundamental understanding of the polymer-nanoparticle-interaction will be used to adapt the SLS process for the selected material to create specimens, which can be tested for their final part properties. This knowledge can then be transferred to nanoparticles of other classes (e.g. metals and oxides) or different powder materials (e.g. HD-PE and TPE), leading to an expansion of the material diversity for SLS.

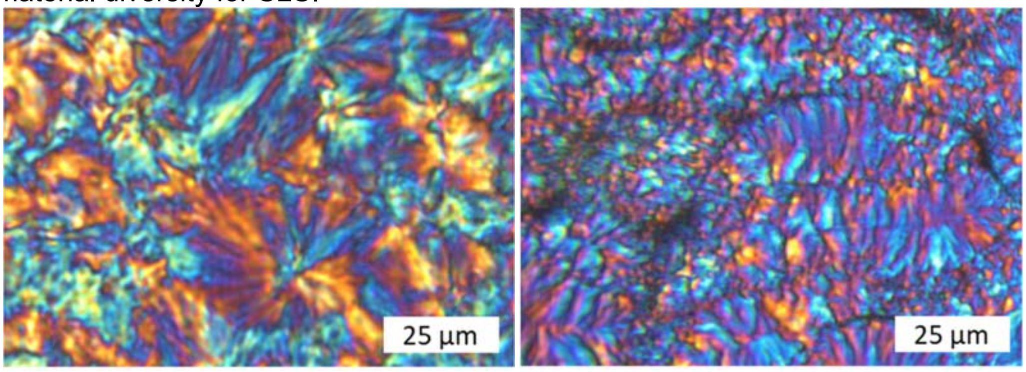

Fig. 1 Comparison of laser sintered samples without (left) and with 0.1 wt% carbon black (right) via polarization microscopy

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