

Powder systems for additive manufacturing of AISi12-CNT composites

Graduate



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Introduction: Carbon nanotubes (CNTs) reinforced materials offer improved mechanical, electrical and thermal properties that make them useful for new applications. Against this backdrop, the main objective of this thesis consists in the development of a composite powder from an aluminum-silicon metal powder and CNTs according to nanosafety standards for additive processing using selective laser melting (SLM). In Figure 1, the utilized CNTs of the company Nanocyl are demonstrated by transmission electron microscope (TEM).

In this context, two different compounding concepts were developed to securely bond the CNTs to the metal powder surface. The first one is based on chemical bonding with surfactants, while the other concept uses physical bonding by a ball milling process.

Approach: Different surfactants were used to practically implement these concepts. In addition, mild functionalization of CNTs with carboxylate groups (-COOH) was performed and detected by infrared spectroscopy.

For the second compounding concept, various series of experiments were performed using a ball mill. A milling process was successfully implemented that fulfilled the nanosafety requirements and ultimately lead to spherical particles suitable for SLM processing and shown in Figure 2.

It was also possible to establish a robust bonding of the CNTs to the metal powder surface via hydrogen bonds utilizing a polymer made of polyvinyl acetate (PVA). The CNT attachment by PVA was demonstrated by scanning electron microscopy (SEM) in Figure 3.

Result: A network-like structure of CNTs sticking on

the surface of a single metal powder particle is visible in Figure 3. Therefore, we were able to fabricate a CNT/metal-composite powder which is suitable for SLM processing also from a nanosafety point of view.

Figure 1: TEM images of individual CNTs
(Source: Nanocyl)

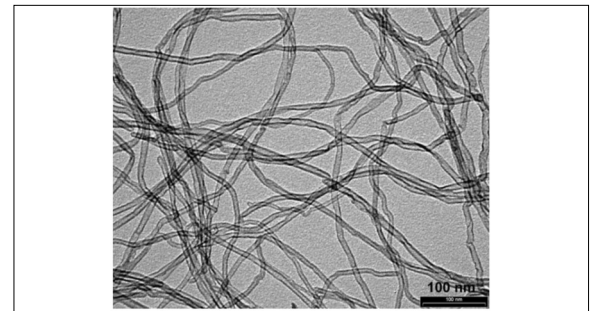


Figure 2: SEM images of milled AISi12-particles after 38 h
(Source: Own presentation)

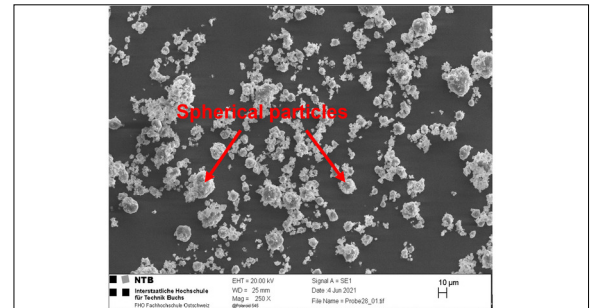
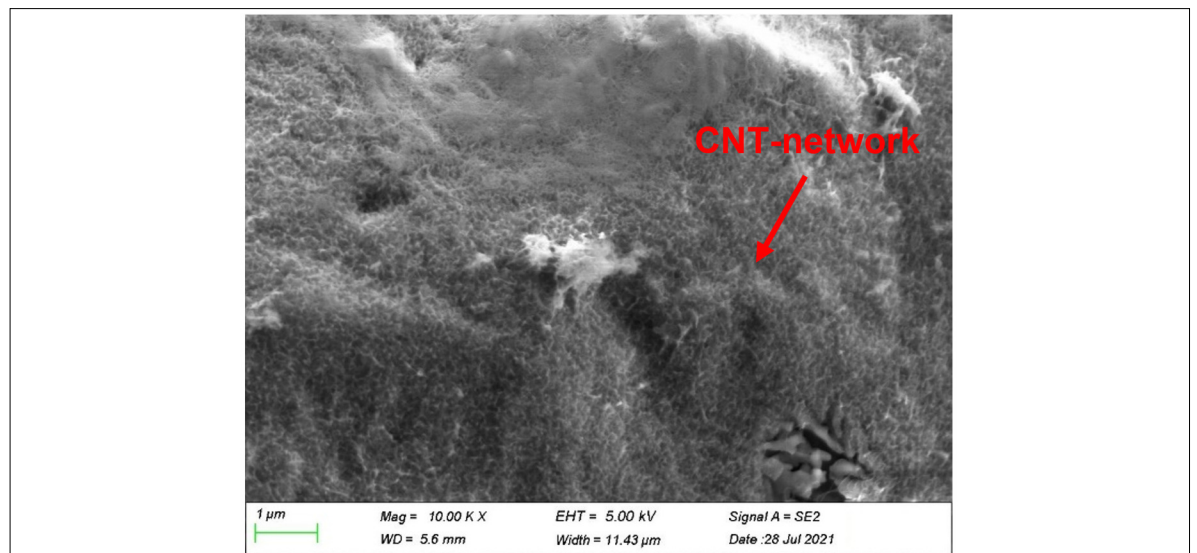


Figure 3: SEM image of an AISi12-particle with a CNT-network on the surface
(Source: Own presentation)



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