Nanocomposite of Poly L-lactic acid with inorganic nanotubes (Ramot)

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Strong, tough and bio-degradable polymer-based 3D-ink for fused deposition modeling (FDM) using inorganic WS2 nanotubes.

WS2-NT are metals dichalcogenides nanotubes (NT) of the shape MX2 (M = transition metal, Mo, W, etc.; X = S, Se, Te). In its tube form, WS2 is a semiconductor, nontoxic, and dispersible in both organic solvents and polymers. With a Young's modulus of 150 GPa, bending modulus of 217 GPa, tensile strength between 16–20 GPa and strain at failure larger than 10%, WS2-NT are a non-toxic alternative to Carbon Nanotubes (CNT).

Due to the biodegradability of PLA, and the biocompatibility of WS2-NT, PLA/ WS2-NT is a biodegradable nanocomposite. Reinforced PLA is used in biodegradable scaffolds for tissue engineering with improved mechanical and rheological properties compared to that of pure PLA, with little change in the polymer viscosity. Thus, a solvent-free extrusion is used to create a bio-degradable, mechanically reinforced nanocomposite filament. The filament can then be processed by Fused Deposition Modeling (FDM) 3D-printer.

The Need

Bio-compatible polymers are used in catheters, 3D-printed orthopedic devices, food packaging etc. However, being usually based on weak chemical bonds, most bio-compatible polymers are mechanically weak, with limited thermal and structural stabilities, and thus have short shelf life.

Project Status

The processes of solvent-free extrusion has been established and is well controlled. The composite filament has successfully been printed using commercial-grade FDM. The addition of WS2-NT to PLA by extrusion mixing increases the elastic modulus, yield strength and strain-at-failure by 20%, 23% and 35% respectively. Moreover, the printing process itself improves the dispersion of WS2-NT within the PLA filament, and does not require changing of the printing parameters compared to pure PLA. Further improvement using surface-treatment on the WS2-NT, as well as co-reinforcing the PLA using WS2-NT and hydroxy apatite nanoparticles are also underway.

Patents

US Patent Application pending.

Supporting Publications

Shalom, H. et al. Nanocomposite of poly(L-lactic acid) with inorganic nanotubes of WS2. Lubricants 7, (2019)

Shalom, H. et al. Strong, tough and bio-degradable polymer-based 3D-ink for fused deposition modeling (FDM) using inorganic WS2 nanotubes. Scientific Reports, Submitted 2019

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