VAT PHOTOPOLYMERIZATION 3D PRINTING OF SELF-LUBRICATING POLYMER COMPOSITES

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Self-lubrication; Polymer composite; 3D printing

ABSTRACT

With the superiorities of light weight, corrosion resistance, low noise and long-term maintenance-free, self-lubricating polymer composites have a variety of applications in aerospace, automotive industry and other frontier fields. Typically, polymeric self-lubricating composites can be classified as solid-liquid and solid-solid composites according to the filler. In our work, two manufacturing strategies for self-lubricating polymeric composites are proposed, namely the vat photopolymerization 3D printing of microemulsion (microemulsion-3DP, solid-liquid composites) and three-dimensional target-region-lubrication printing (solid-solid composites). The microemulsion-3DP is applied for one-step fabricating self-lubricating parts with microdroplets of oil filled in polymer. In this work, talc, as an emulsion, was incorporated into the microemulsion to ensure the oil-droplets evenly and stably dispersed for Vat photopolymerization 3D printing. And the oil-droplets were fixed in the microemulsion in the process of the ink from liquid to solid in the subsequent 3D printing, that enable the one-step filling of liquid oil-droplets. Then, the complex self-lubricating structures would be fabricated via 3D printing, which realized the forming of oil-containing self-lubricating composites with complex structures in one step. For three-dimensional target-region-lubrication printing, photosensitive polyimide filled with poly-tetrafluoroethylene (PTFE) with excellent tribological properties for self-lubricating devices. The surface with lubricating only in regions where needed were readily realized due to the layer-by-layer manufacturing manner of 3D printing. We integrated surface patterning with the layer-by-layer forming principle of additive manufacturing and the Yin-Yang theory in traditional Chinese to investigate the tribological properties of alternating lubricated surfaces, the tribological data using machine learning and the optimized surfaces demonstrated the exceptional comprehensive properties. The two novel manufacturing strategy for polymeric composites provides new ideas for manufacturing self-lubricating parts and presents new opportunities for self-lubricating 3D architectures with rapid manufacturing, low-cost and free manufacturing.

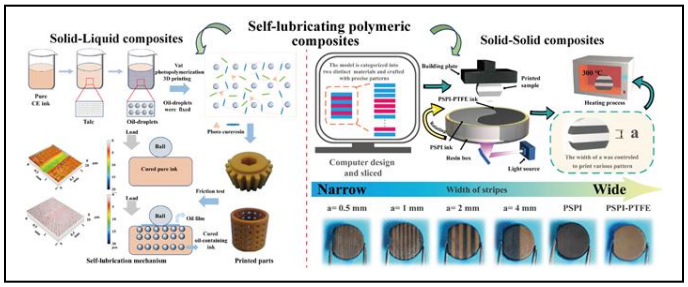

Fig.1 Microemulsion-3DP and 3D target-region-lubrication printing are proposed for solid-liquid and solid-solid self-lubricating polymeric composites. The composites fabricated by the manufacturing strategies have excellent self-lubricating properties, which can also meet the manufacturing requirements of increasingly diversified self-lubricating devices.

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