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3D printing for continuous fiber reinforced thermoplastic composites

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Low-cost and high-efficiency manufacturing technologies for composite components are very important to further industrial applications. A novel 3D printing based fabrication method for continuous fiber reinforced thermoplastic composites (CFRTPCs) was put forward to overcome limitations of conventional forming process in expense and efficiency. Continuous fiber and thermoplastic filament were utilized as reinforcing phase and matrix, respectively, and simultaneously fed into the fused deposition modeling (FDM) process realizing the integrated preparation and forming of CFRTPCs without molds. Continuous carbon fiber reinforced poly lactic (CF/PLA) are used to print specimens to systematically study the influence of process parameters to mechanical properties and interfaces performance. The performance of parts changed regularly with variable process parameters, such as temperature of liquefier, layer thickness, hatch spacing, and feed rate of filament. Measurements of flexural strength and microstructures were conducted to establish the correlation of process parameters, microstructures, and mechanical performance. The forming mechanism of multiply interfaces in the 3D printed composites was proposed and utilized to explain the correlations between process and performance. Maximum flexural strength and modulus for CF/PLA specimens can reach to 335 MPa and 30 GPa, respectively, with optimized process parameters. Also, the fiber content can be easily controlled by changing the process parameters and maximum values of 27% were achieved. Composite components were fabricated to demonstrate the process feasibility in the rapid fabrication of light and complex composite structures. Potential applications in the field of aviation and aerospace could be found in the future.

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