Modulating Z-Axis Movement to Increase the Layer Adhesion of 3D Printed Parts

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Globally, the most widespread 3D printing method uses FDM (Fused Deposition Modeling), which often suffers from poor layer adhesion. When a tensile or shear force is applied to an FDM printed part, mechanical failure tends to occur along layer lines because of limiting bonding between consecutive layers. This significantly hinders the applicability of FDM parts, as tensile/shear forces have to be minimized, and/or additional material must be added to parts. The project analyzed whether modulating the motion of a 3D printer's printhead can increase the strength of parts. By introducing downwards then upwards "travel" movements at regular intervals, it was possible to reheat and increase the surface area of layers to facilitate their bonding. The project uses a self-programmed Python G-code parser to apply the technique to any 3D model with virtually any FDM printer. For testing, ISO 527 and ISO 179-1 samples were printed from numerous plastics and were tested on a universal and Charpy impact test machine. The technique proved to significantly increase the layer adhesion of several plastics, with certain filaments exhibiting 8.6 times the tensile strength compared to a standard part printed under identical conditions. Nearly all plastics showed a statistically significant tensile and impact strength increase. If widely adopted, the technique could increase the applicability of 3D printers, leading to more efficient designs and a sizable decrease in plastic waste creation. The method could be used to strengthen both industrial parts (such as automotive or aerospace components) and also home 3D prints.

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