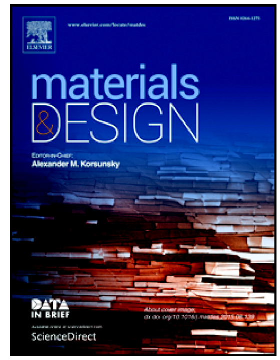
Accepted Manuscript



Evaluation of carbon fiber-embedded 3D printed structures for strengthening and structural-health monitoring

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PII: S0264-1275(16)31387-9
DOI: doi: 10.1016/j.matdes.2016.10.078
Reference: JMADE 2435

To appear in: *Materials & Design*

Received date: 23 September 2016
Revised date: 28 October 2016
Accepted date: 31 October 2016

Evaluation of carbon fiber-embedded 3D printed structures for strengthening and structural-health monitoring

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Abstract: This paper presents a technique for both structural reinforcement and self-monitoring of thermoplastic parts manufactured by fused deposition modeling (FDM). Continuous carbon fiber tows were embedded into FDM printed structures during the printing process, and the strength and piezoresistive behavior of the printed structures were evaluated. The specimens reinforced with carbon fibers have a tensile strength increase of 70% and flexural strength increase of 18.7% compared to non-reinforced specimens. In addition, the slope of fractional change in electric resistance with strain became a good indicator of strain measurement within the elastic region and damage detection in the yield region. Furthermore, lightweight and print duration reductions were achieved by decreasing the fill density while maintaining the structural strength, where up to 26.01% weight reduction and 11.41% print time reductions were achieved without decreasing the tensile strength. Finally, an artificial hand printed by FDM with embedded carbon fibers is discussed as a demonstration of this approach.

Key works: Carbon fiber, strengthening, monitoring, 3D printed structure, reinforcement

1. Introduction:

Recently, fused deposition modeling (FDM) has become one of the most popular 3D printing technologies due to its simplicity, low-cost, and the potential applications for the method [1, 2]. However, FDM products still have deficiencies regarding poor mechanical strength due to the inherent nature of thermoplastic resins, which greatly limit industrial applications [3-5]. On the other hand, reductions in material, as a sustainability requirement for industrial applications, is also of significant importance