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Estimation of High Speed Sintered Nylon-12 Tensile Strength Using Visible Reflectance Spectroscopy

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Abstract

Additive Manufacturing (AM) refers to a class of manufacturing processes which produces three dimensional objects directly from 3D model data. A range of AM processes, such as fused deposition modelling and laser sintering are deemed slow compared to injection moulding, as they depend on point-to-point consolidation. In order to progress into high speed manufacturing, a novel process called the High Speed Sintering (HSS) process is currently being developed at the University of Sheffield.

HSS is a powder bed fusion process which employs an inkjet print head to print a cross sectional image of an object in radiation absorbing material (RAM) onto a powder build bed.[1] The build bed is subsequently exposed to infrared radiation to promote selective sintering of RAM coated powder, leaving the surrounding powder to act as a support. Consolidation is obtained by adding a new layer of powder in between printing successive images to form a 3D object. The HSS process uses Nylon-12 as its standard material, and is suitable to use with a range of polymer powder, especially thermoplastics. An overview of the HSS process with its key components is illustrated in Figure 1 below.

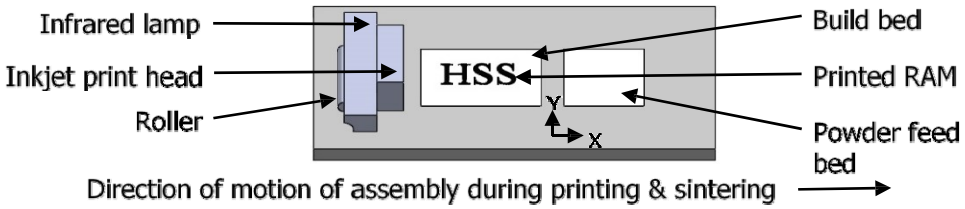

Figure 1. Key components in the High Speed Sintering (HSS) process

Previous research on HSS has focused on assessing the effect of infrared lamp level,[2] the addition of flow agent[3] and the greyscale value on the mechanical properties of parts. Few studies have been performed on non-destructive characterisation of polymer parts, either by using Differential Scanning Calorimetry (DSC)[5] or NIR spectroscopy for laser sintered parts [6] and rubber parts [7].This project aims to propose a non-destructive method to estimate the tensile properties of HSS Nylon-12 parts. Previous research based on the "greyscale level" suggested a correlation between the input ink dithering level during sintering process and the resultant parts tensile properties, however this method is not widely applicable across all inkjet print heads due to the difference in specifications. Spectroscopy method has never been used to assess parts made by the high speed sintering process and is advantageous as it quantifies an output grey level.

In this contribution, an overview of the HSS processing of Nylon-12 powder will be provided. Reflectance spectroscopy will be performed on manufactured parts and the results compared with actual tensile tests. The correlation between HSS Nylon-12 parts reflectance values and their corresponding ultimate tensile strength values will be presented.

Keywords

{Reflectance, inkjet printing, high speed sintering}

Biography

Farhana Norazman is a PhD student within the Advanced Additive Manufacturing (AdAM) group at the University of Sheffield, having previously obtained her masters in mechanical engineering from the same university in 2013. Her PhD focuses on polymer sintering using the high speed sintering process.

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