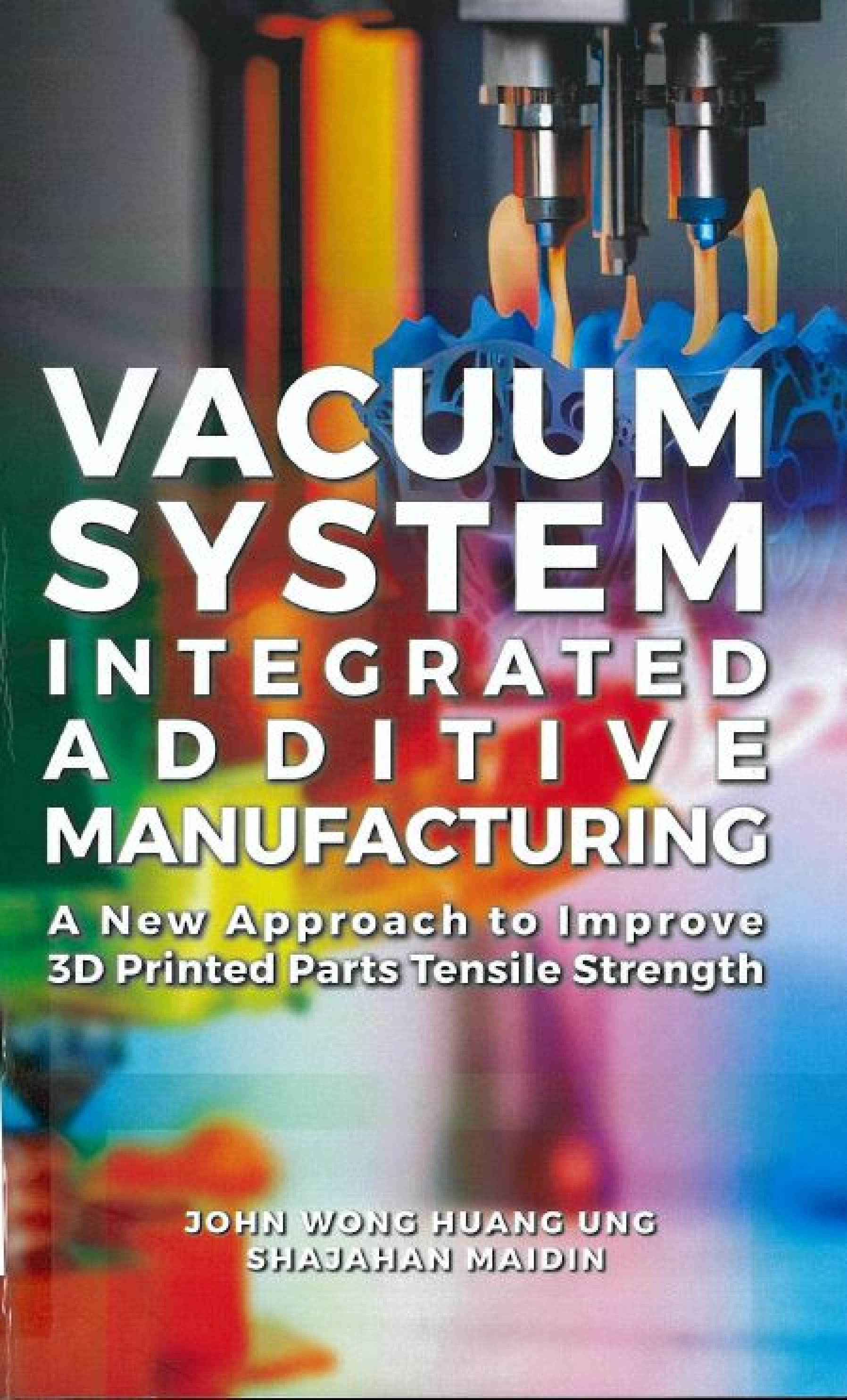

VACUUM SYSTEM INTEGRATED ADDITIVE MANUFACTURING

A New Approach to Improve 3D Printed Parts Tensile Strength

JOHN WONG HUANG UNG
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Additive manufacturing (AM) has come a long way and has begun to be acknowledged and accepted in numerous industries such as aerospace, automotive, medical, and even art. Fused deposition modeling (FDM), as one of the AM technologies, is a popular and most used technology based on the polymer extrusion method. Despite having the advantage to produce part without any complexity restrictions, the known poor mechanical strength for a functional part produced is the limitation. Literature has found out that one of the main reasons for anisotropic behaviour, which was the insufficient bonding between layers, was found weakest at the z-axis. The layer-by-layer bonding occurred too fast and was not fully fused together, causing weak structural strength and easily shattered through pulling force. It was found that vacuum technology could improve layer bonding by reducing convective heat transfer. In a vacuum environment, the reduced amount of air molecules hindered the heat energy from being released from the deposited filament. The pilot test confirmed that the different level of vacuum pressure does affect the tensile strength of the printed parts. A total of 20 experiment runs with 60 printed specimens were conducted with two parameters, namely layer thickness and vacuum pressure. Results have found out that the highest percentage improvement (16.77 %) was 18.0846 N/mm^2 produced by 0.20 mm/21 inHg, while the highest strength was measured at 0.25 mm/21 inHg, giving 19.7202 N/mm^2. The z-axis produced in a vacuum environment was now at 77.67 % of strength produced by x-y axes signifying reduced anisotropic behaviour. It was found out that under a scanning electron microscope (SEM), the specimens produced under vacuum pressure had a better bonding formation compared to normal atmospheric ones. Lastly, the ANOVA method had validated the significance of the set of parameters and the optimised parameter was 0.25 mm/21 inHG for recommended tensile strength while 0.22 mm/21 inHg for recommended tensile strain. The vacuum-assisted FDM has proven to be feasible, and this study had increased the understanding of vacuum technology and FDM to improve the tensile strength of the printed part. Further improvements of vacuum-assisted FDM will allow the creation of mechanically stronger complex parts in a wide range of applications.

JOHN WONG HUANG UNG, received his Master of Science and Bachelor of Engineering (Hons) in Manufacturing Engineering majoring in Design Manufacturing from Universiti Teknikal Malaysia Melaka. He started his professional career at SG Endoscopy Pte Ltd based in Singapore as a Design Engineer specialized in product design and development as well as manufactures of medical devices for a US companies. His area of interest includes mechanical design, manufacturing process, machining and additive manufacturing.

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