3D-Printed Polylactic Acid Reinforced Carbon Fibre in Bulk and Triply Periodic Minimal Surfaces (TPMS) Lattice Structure: A Mechanical Properties Analysis Comparative Study

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Focusing on producing lightweight yet maintaining their mechanical integrity at upmost levels made triply periodic minimal surfaces (TPMS) lattice structure one of the promising structures can be applied [1]. Therefore, this study investigates the mechanical performance of polylactic acid (PLA) reinforced with 15wt.% carbon fibre (CF), in both bulk and TPMS lattice. Filaments were fabricated in-house and printed using fused deposited modelling. Results indicated that the 15wt.% bulk structure exhibited a 60% increase in tensile modulus compared to pure PLA when tested between 30°C and 80°C, indicating effective stress distribution within the fibre networks. Further analysis of gyroid and honeycomb TPMS lattice revealed a 56% difference in compressive strength compared to the bulk structure. These findings highlight the potential of TPMS structure in enhancing mechanical performance while reducing weight and having the used of sustainable polymeric composites [2,3]. The experimental setups for compression test are shown in Figure 1, with the digital camera positioned in front of the specimens to record the deformations.

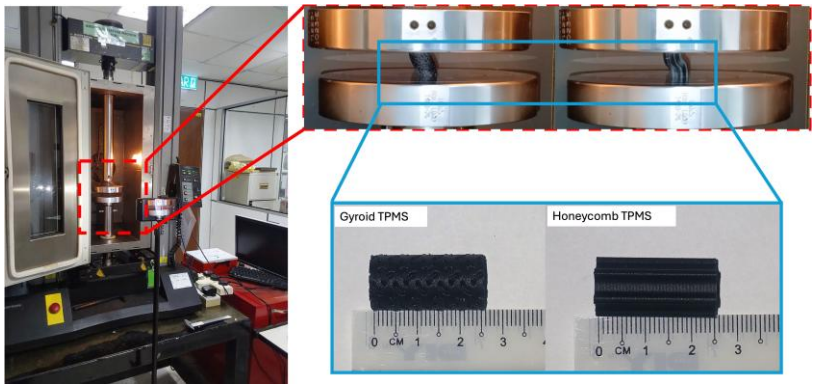

Figure 1: The compression test setups for both bulk and TPMS lattice structure samples.