Thermal and Acoustic Characterization of Hybrid Triply Periodic Minimal Surface Structures

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With the increasing use of high-performance CPUs and GPUs, thermal management has become crucial. Conventional cooling methods, such as heat sinks and air coolers, often generate continuous noise, causing user discomfort. This study investigates the thermal dissipation and sound absorption of Triply Periodic Minimal Surfaces (TPMS) and develops a Hybrid-TPMS configuration to enhance both functions. Thermal dissipation of Gyroid, Diamond, Lidinoid, and Split-P TPMS structures with varying offset thicknesses was analyzed under forced convection, while sound absorption coefficients were measured using a dual-microphone setup. Thermal simulations identified the S(0.6) structure as having the lowest maximum temperature of 55°C, while acoustic tests showed the D(0.65) structure with the highest sound absorption coefficient of 23.2%. A Hybrid-TPMS combining S(0.6) and D(0.65) in a S20D80 ratio was developed, achieving a maximum temperature of 57.3°C and a sound absorption coefficient of 25%. Comparative analysis revealed that the Pin Type Heat Sink reached 93°C, while the Hybrid-TPMS maintained 57.3°C, reducing the temperature by 35.7°C. These findings demonstrate the potential of Hybrid-TPMS for applications requiring simultaneous heat dissipation and noise reduction, improving thermal performance and providing a quieter environment for high-performance computing.

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