On characterizing the topology and geometry of imperfect gyroids.

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Triply periodic network morphologies are commonly found across various self-assembled soft matter systems, including diblock copolymers. Among these is the double gyroid phase, characterized by two distinct and interpenetrating tubular minority domains embedded within a majority domain whose shape approximates a finite-thickness gyroid minimal surface. In real systems, these crystalline double-networks often coexist with defective or disorder variants of the same networks. In this study, we exploit 3D tomographic restrictions of polystyrene–polydimethylsiloxane (PS–PDMS) diblock copolymer samples to examine boundaries between well-formed (that is, cubic) double gyroid networks and "aperiodic network" regions that tend to form in inter-grain regions. Despite the lack of long-range order in the aperiodic network, we find that it predominantly exhibits the same 3-valent tubular network connections as the ordered double-gyroid, but with a much more variable structure of looping. Using tools from network theory and geometry, we characterize the structure of the aperiodic regions. Through this analysis, we hope to uncover how aperiodic regions, consisting of a single network domain, transform into ordered double gyroids, comprising two separate network domains.