Macro scale gyroid applications

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The gyroid TPMS discovered by Schoen in 1970 (ref. 1) is a fundamental building block which self-assembles at nano scale (ref. 2). It is found at nano scale in plant and animal kingdoms, as well as at micro scale in sea urchins (ref. 3). The gyroid surface divides 3D space into two interlocking spaces and exhibits high surface to volume ratio. Flow through each of the two spaces branches repeatedly, with a left-hand spiral branch and a right-hand spiral branch at each intersection.
The elegant complexity of the gyroid structure has made it difficult to reproduce at macro scale. As 3D printing processes have improved, the gyroid has become a popular infill, reducing weight while maintaining structural stability, and self-supporting during the printing.
Using numerical analyses and 3D printing, gyroid structure has been proved useful at millimeter scale for processes requiring countercurrent flow (e.g.: active heat exchange (ref. 4), mass transfer), and for mechanical properties of objects that require both strength and reduced weight (e.g.: passive heat exchange, packaging, bone replacement). At larger scale, architectural uses have been suggested (e.g.: wall, bridge). A relatively straightforward method of assembly is described for creating gyroid structure using traditionally manufactured parts (cast, milled, injection molded, etc.).

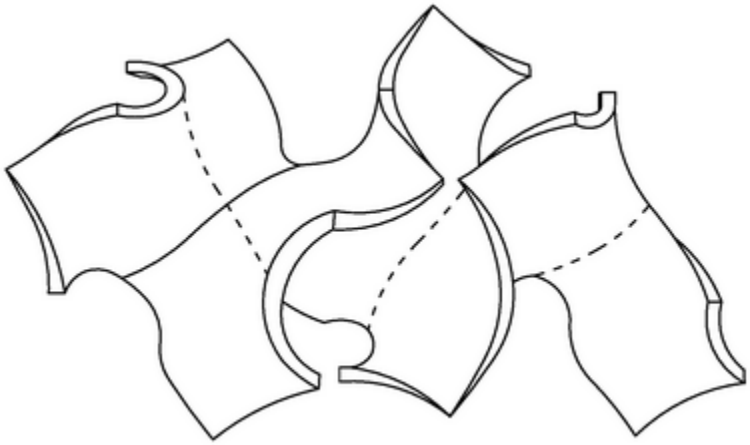

Figure 1 Gyroid pipe assembled from 10 skew hexagons.

[1] A. H. Schoen, NASA Technical Note D-5541 (1970).
[2] S. Hyde, S. Andersson, K. Larsson, Z Blum, T Landh, S. Lidin, B. W. Ninham, The Language of Shape: The role of curvature in condensed matter: Physics, chemistry and biology, (1997).
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[4] B. W. Reynolds, C. J. Fee, K. R. Morison, D. J. Holland, International Journal of Heat and Mass Transfer 212 (2023) 124264, (2023)