MAR15-2014-020786

Abstract for an Invited Paper
for the MAR15 Meeting of
the American Physical Society

Multiple networks in soft materials: polycontinuity

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Bicontinuous network phases contain a pair of interwoven labyrinths. Analogous patterns with 3,4, .., 8, .., 54,... labyrinths are readily constructed via 2d hyperbolic geometry. Some of these have been realised in synthetic materials, from mesoporous silicates and lyotropic liquid crystals to metal-organic frameworks. We stumbled on polycontinuous forms while exploring 2d hyperbolic geometry.[1] The only known tricontinuous phase found to date in mesoscale self-assembled materials was described via 2d non-euclidean geometry[2] many years before its discovery.[3] This example demonstrates the relevance of regular patterns in non-euclidean 2d spaces to self-assembled morphologies in actual materials. One route to explicit ground-up design of mesoscale polycontinuous phases is via star-shaped molecules with immiscible arms, such as Y-shaped "polyphiles." Some results of theoretical geometric modelling,[4] simulation[5] and experimental formulation of lyotropic LC mesophases with polyphiles[6] will be discussed.

[1]Eur Phys J B, 16, 613-630 (2000)
[2]Curr Opinion Coll Interf Sci, 8, 5-14 (2003)
[3]Nat Chem 1, 123127 (2009)
[4]Acta Cryst, A69, 241-261 (2013)
[5]Proc Natl Acad Sci. USA, 111, 12711276 (2014)
[6]Chem Mat, in press (2015); in preparation