

Synthesis of aramide rod-like molecules and re-entrant honeycomb structure for the investigation of auxetic polymers

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Auxetic materials are characterized by a negative Poisson's ratio (NPR), which means they tend to expand perpendicularly to the applied force when stretched, unlike non-auxetic materials, which would shrink under same conditions. Auxetic behavior can be achieved with different architecture and shows to be scale independent¹. Auxetic polymeric materials are of interest since they are expected to have mechanical properties such as a higher shock absorption and greater fracture resistance due to their intrinsic molecular structure compared to their non-auxetic counterparts. So far, a series of these materials have been produced in the form of foams, fibers and composites. Some molecular-level auxetic polymers have been theoretically designed, but they have not been synthesized yet. That is why this project is focused on auxetic polymeric materials on the molecular level.

In this study the exploration of polymeric molecular auxeticity of rod-containing polymers² and re-entrant honeycomb structure^{3, 4} were designed and investigated. The molecular geometric shapes were synthetically achieved via shape persistent aromatic amide oligomers for the rod-containing polymers and their aggregation was studied. Several rod-containing polymers were synthesized containing different percentage of rods, see figure 1. Gel permeation chromatography (GPC) and dynamic light scattering (DLS) experiments indicate an increasing size particles according to the increasing rod percentage. A synthetic route for the polymer with re-entrant honeycomb shape via Sonogashira cross-coupling metathesis and coupling of an amine with acyl chloride is proposed. A designed re-entrant honeycomb structure is shown in the figure 2.

References:

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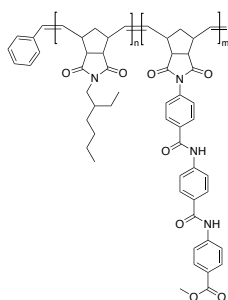


Figure 1 : Synthetic Rod-containing polymer type

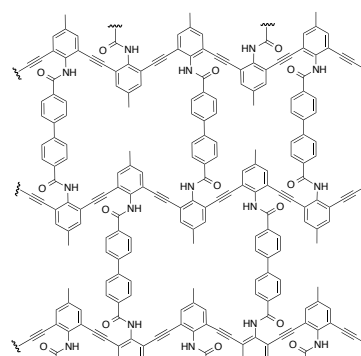


Figure 2 : Proposed re-entrant structure