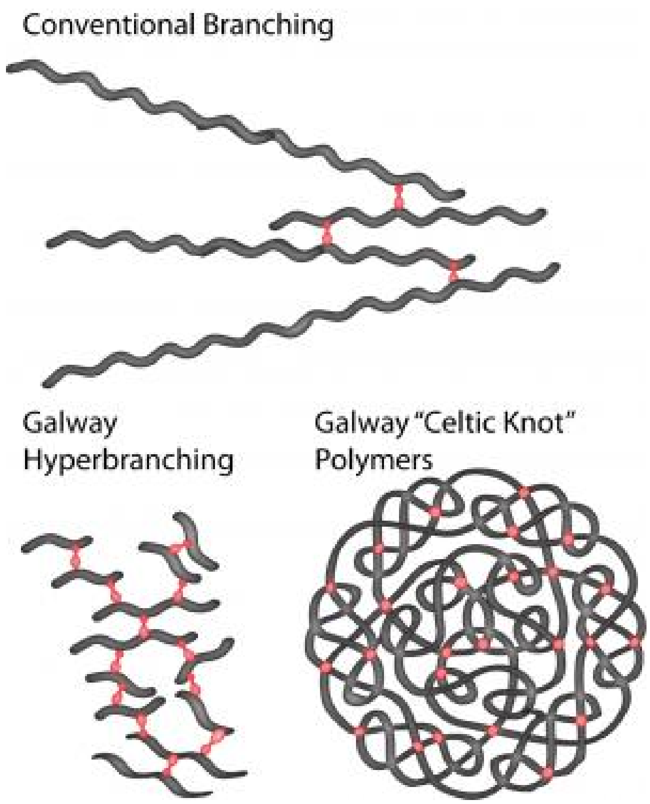
# Polymer breakthrough inspired by trees and ancient Celtic Knots

May 22 2013




A new slow-motion method of controlling the synthesis of polymers, which takes inspiration from both trees and Celtic Knots, opens up new possibilities in areas including medical devices, drug delivery, elastics and adhesives.

Scientists at the Network of Excellence for Functional Biomaterials (NFB) in the National University of Ireland Galway have just published their breakthrough polymerization method in *Nature Communications*. Their new polymerization technique allows for the easy creation of new complex, multi-functional, branched compounds.

The research team was led by NFB's Dr Wenxin Wang at the National University of Ireland Galway, who said: "The versatility of our synthesis process could allow us to tailor polymer properties, such as structure, functionality, strength, size, density and degradation - with previously unimaginable ease."

The researchers took inspiration from ancient arts, and use their new technique to build up 'Celtic Knots'. These materials have chains that only link to themselves in an interlaced pattern. In addition, the new technique can also create hyper-branching polymers, which branch and spread outwards like trees.

Polymers are a broad class of natural and synthetic compounds, built up of many parts known as monomers, which connect together in fast growing chains. Until now, creating more complex branched polymers, known as dendrimers (from the Greek word "dendron" meaning "tree"), has been a labour intensive and time consuming process.

Now, for the first time, "dendritic" or tree like polymers have been synthesised in bulk, with branch points after every few monomers of the build process. This allows a far higher degree of branching than previously obtainable, and opens up new possibilities for the use of polymers.

The new process developed by the team, in collaboration with Dr Julien Poly from the Institut de Science des Matériaux de Mulhouse, France, is called 'vinyl oligomer combination'. In effect the process allows a simple "one-pot" procedure that leads to easy up-scale of the process.The expectation is that these intricate woven and branched polymers will be cheap to produce and high in quality, as the technique is fully scalable.

Dr Wenxin Wang is trying to uncover therapies for diseases such as diabetic ulcers and Epidermolysis Bullosa, which causes chronic skin conditions: "We are currently investigating the use of these new materials for biomedical applications such as drug/gene delivery, cross linkable hydrogel materials and skin adhesives. However, in reality this synthesis method could be used for a wide range of materials outside the biomedical field."

Dr Wenxin Wang continued: "It is interesting to note the period of difficulty often encountered with break through developments. For example, the road to acceptance of dendrimer materials was long and winding. Because this work contradicts long-standing theories about polymerization, we too have faced the challenge of acceptance. Finally, researchers are seeing the importance of these materials, and the ease at which new structures can be synthesized. Although these are early steps, we are looking forward to seeing the future realization of these structures in a wide range of applications."

**More information:** Zhao, T. et al. Controlled multi-vinyl monomer homopolymerization through vinyl oligomer combination as a universal approach to hyperbranched architectures, *Nature Communications* 4, Article number:1873. doi:10.1038/ncomms2887

Provided by National University of Ireland, Galway