University of Fribourg / Faculty of Science and Medicine / Department of Chemistry

Auxetic polymeric material: rod-containing polymers

Phally Kong

The main project of this thesis deals with auxetic materials that are characterized by a negative Poisson's ratio, which means that they tend to extend perpendicular to a force applied when stretched. On the contrary non-auxetic materials would shrink under similar conditions. The auxetic behavior can be achieved with different material architecture and can be achieved on various scales. Polymers possessing these characteristics are of considerable interest because they are supposed to have interesting mechanical properties such as better shock absorption and greater fracture resistance because of their intrinsic molecular structure compared to equivalent materials not having this property. So far, a few series of these materials have been produced in the form of foams, fibers and composites. Some polymers, possessing this property at the molecular level, have been theoretically designed, but they have not yet been synthesized. This project tries to fill this gap.

The aim is to incorporate rod-shaped *para*-terphenyl molecules in a covalent and non-covalent manner in an elastic polymeric matrix, namely thermosetting poly(dimethylsiloxane). Linear dichroism UV-vis spectroscopy was used as a method to probe the rod orientation changes in perpendicular and parallel to the stretching flow. Results show the perpendicular absorption of the covalently bonded rods is higher than the parallel one, while the UV-absorption of those that are non-covalently bonded show the opposite. Moreover, the system shows a reversibility effect.

The second project deals with lateral rod-containing polymers. To achieve that, two types of rods based on oligo-aramids were designed and synthesized. These oligomers are well known to adopt shape-persistent rigid rods. One is based on tri(*p*-benzamide) and can undergo intermolecular interaction *via* hydrogen bonds, while the second one based on 4-aminosalicylic acid derivative can undergo intermolecular interaction *via* π-π-stacking. The syntheses of polymers containing randomly lateral rods linked to poly(norbornene) have been achieved using ring opening metathesis polymerization. Different molar concentrations of rods have been explored. Their thermal and mechanical properties have been studied in order to compare their influences on the glass transition temperature with respect to the nature of the rods. The results extracted from different analysis techniques showed a clear influence on the glass transition temperature by increasing the thermostability of the polymers proportionally to the molar content of these rods.

Jury:

Prof Dr. Andreas F. M. Kilbinger, (thesis supervisor)
Prof Dr. Christian Bochet, (internal co-examiner)
Prof Dr. André R. Studart, (external co-examiner)
Prof Dr. Marco Lattuada, (president of the committee)