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Sustainable polymer networks for advanced applications based on dynamic covalent bonds

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Synthetic polymers are one of the most important inventions of mankind, which are often categorized into two basic categories named thermoplastics and thermosets. Thermoplastics are linear polymer chains with the capacity to be reprocessed at high temperatures. Thermoset polymers, on the other hand, are made up of chemically crosslinked networks. Owing to their different topological structure, thermosets usually outperform thermoplastics in shape stability and creep resistance, but have worse reprocessing and recyclability. With the development of covalent combinatorial chemistry, vitrimers, a group of dynamic polymer network, were first introduced by Leibler et al. in 2011.[1] As a class of new covalent associative networks (CANs), vitrimers provide a solution to combine the best of both worlds. By including an appropriate transesterification catalyst to polyester-based epoxy resin networks, the permanent networks exhibit a gradual viscosity decrease upon heating, similar to vitreous silica, which is why the term "vitrimer" was coined.
In the last decade, vitrimers have drawn significant attention due to their recyclability, but they shouldn't be solely constrained to recycling thermosets in traditional plastic applications, like packaging, casting, and construction.[2] Therefore, a library of sustainable dynamic polymer networks, vitrimers were developed for advanced applications. Owing to the synergy of dynamic covalent bond exchange reactions and employed function groups, a series of novel vitrimers were created to fit various applications, including water remediation, motion monitoring, energy harvesting and healable 3D printing.

References:

[1] Damien Montarnal, Mathieu Capelot, François Tournilhac, Ludwik Leibler, " Silica-Like Malleable Materials from Permanent Organic Networks ", Science.1212648
[2] Ning Zheng, Yang Xu, Qian Zhao, and Tao Xie, " Dynamic Covalent Polymer Networks: A Molecular Platform for Designing Functions beyond Chemical Recycling and Self-Healing", Chem. Rev. 2021, 121, 1716−1745

CV: Dr. Chongnan YE
Chongnan YE is a postdoc researcher from University of Groningen. He comes from China and obtained his bachelor degree in materials science and technology at University of Jinan. Then, he came to the Netherlands for his master program study in polymer chemistry at University of Twente. After that, he has moved to Groningen to continue his PhD life in the hybrid program between University of Groningen and NHL Stenden University of Applied Sciences, since 2017. He is now working on the dynamic covalent polymer networks (or called vitrimer) synthesis and application.