Spontaneous synthesis of homogenous polymer networks

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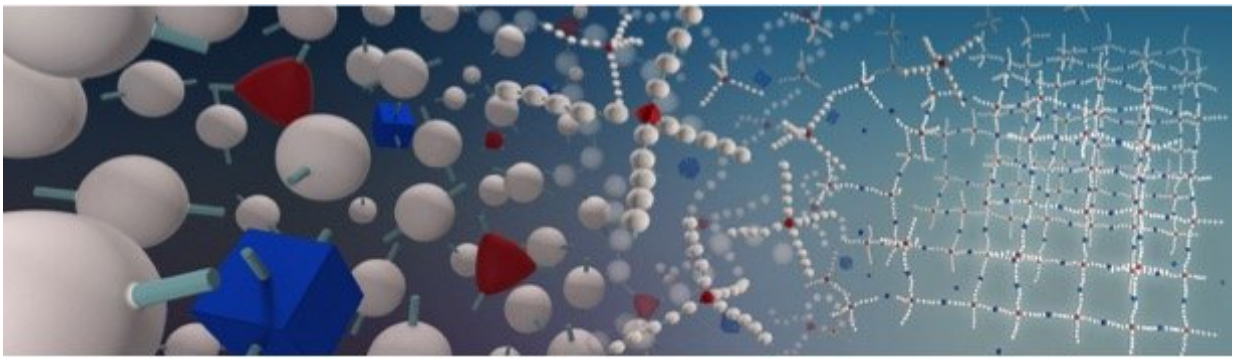

Fig. 1: Schematic illustration for spontaneous synthesis of a homogeneous thermoresponsive polymer network composed of narrow molecular weight distribution polymers. Credit: Nagoya University

Nagoya researchers developed a spontaneous polymer network synthesis that allowed for the preparation of gels containing narrow molecular weight distribution polymers. The gel networks showed swelling properties that were responsive to temperature and solvent concentration. The reported process demonstrates the potential for facile preparation of high quality materials that exhibit the full range of polymer gel properties, including sustained release, stimuli responsiveness, and molecular sieving, amongst others.

Polymer gel materials have been widely applied in medicine, civil

engineering, architecture and space exploration. Their appeal lies in the potential for preparing functional materials with consistent properties, via simple and easily reproducible methods. However, the compromise between method simplicity and optimized material performance means that not all gel materials fulfill their potential. Now a group of researchers at Nagoya University has established a process that combines the ease of a spontaneous process with the high molecular weight control required for producing high-performance materials. Their findings were published in *NPG Asia Materials*.

The straightforward nature of polymer gel preparation makes them attractive for numerous applications. However, controlling reactions so that all of the polymer molecules grow to the same length and then cross-link in a regular fashion can be challenging. Inconsistencies in the structure can form, and short-chain branching can occur during the assembly of the monomers—both of which lead to low-quality materials.

"We have demonstrated a system that uses differences in reaction kinetics to create highly consistent materials," corresponding author Yukikazu Takeoka says."Using a single catalyst that allows chain growth to proceed before cross-linking begins, we have been able to create networks comprised of polymers with narrow molecular weight distributions, simply by mixing the required reagents."

Balancing the rapid polymerization of a chosen monomer with a sufficiently slow cross-linking process resulted in a spontaneous reaction to give a regular homogeneous matrix. The stable gel was shown to exhibit responsive properties controlled by both temperature and solvent composition.

"Narrowing the molecular weight distribution of polymers in a gel network leads to a more consistent, higher-performing material," lead author Yuto Jochi says."It is our hope that we can further refine our

reaction conditions to tailor both polymer molecular weight and stoichiometry of cross-linking, to produce completely homogenous networks that can be used in a variety of applications, such as drug delivery, and lenses."

This spontaneous synthetic route to polymer gel matrices that have the necessary homogeneity and quality to be used in applications requiring diverse features such as molecular sieving, high mechanical strength, transparency, stimuli responsiveness, and biocompatibility is a promising step towards the widespread use of polymer gel materials.

More information: Yuto Jochi et al. Spontaneous synthesis of a homogeneous thermoresponsive polymer network composed of polymers with a narrow molecular weight distribution, *NPG Asia Materials* (2018). DOI: 10.1038/s41427-018-0074-x

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