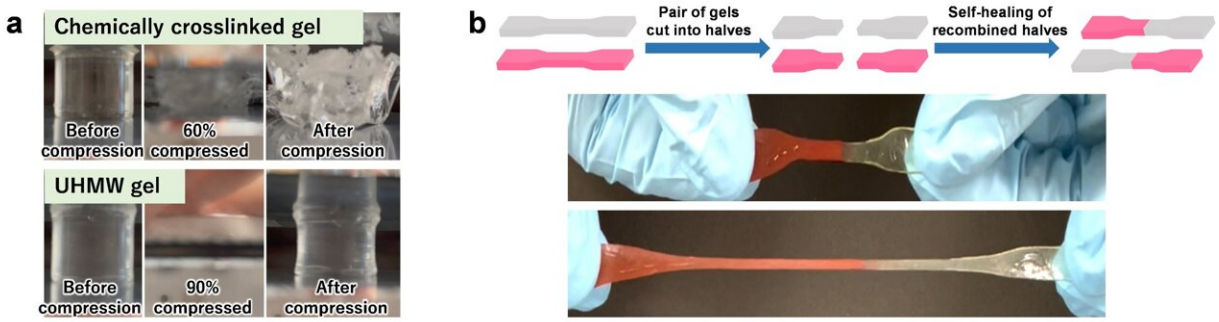
Development of an easy-to-synthesize self-healing gel composed of entangled ultrahigh molecular weight polymers

November 17 2022



(a) Comparison of compressibility between a chemically crosslinked gel and a UHMW gel. (b) Schematic showing UHMW gels' ability to be recombined and the photos of recombined gels being stretched. Credit: Ryota Tamate / National Institute for Materials Science

A research team consisting of the National Institute for Materials Science (NIMS), Hokkaido University and Yamaguchi University has developed a method for easily synthesizing a self-healing polymer gel made of ultrahigh molecular weight (UHMW) polymers (polymers with a molecular weight greater than 10^6 g/mol) and non-volatile ionic liquids. This recyclable and self-healable polymer gel is compatible with circular economy principles. In addition, it may potentially be used as a durable, ionically conductive material for flexible Internet of Things (IoT)

devices. The team's work was published in *Science Advances*.

Self-healing polymeric materials are capable of spontaneously repairing damaged areas, thereby increasing their material lifetimes and making them feasible for promoting a circular economy. Most reported self-healing polymeric materials in recent years has taken a chemical approach, in which functional groups capable of reversible dissociation and reformation (e.g., hydrogen bonding) were integrated into polymeric networks. However, this approach often requires precise synthetic techniques and complex manufacturing processes. On the other hand, an alternative physical approach (i.e., the use of physical entanglement of polymer chains) to synthesizing versatile polymeric materials with self-healing capabilities has rarely been explored.

This research team recently developed a technique for easily synthesizing UHMW gels composed of entangled UHMW polymers using ionic liquids. The mechanical properties of UHMW gels were found to be superior to those of conventional, chemically crosslinked gels. In addition, they can be recycled via thermal processing, and exhibit high self-healing capabilities at room temperature.

The use of the newly developed recyclable, self-healing, easy-to-synthesize UHMW gel material is expected to promote a circular economy. In addition, because this material is synthesized using non-volatile, flammable ionic liquids, it may be used as a safe, ionically conductive soft material in flexible electronics.

More information: Yuji Kamiyama et al, Highly stretchable and self-healable polymer gels from physical entanglements of ultrahigh–molecular weight polymers, *Science Advances* (2022). DOI: 10.1126/sciadv.add0226

Provided by National Institute for Materials Science