

Structurally reinforced hydrogel material developed using electrostatic repulsive force between nanosheets

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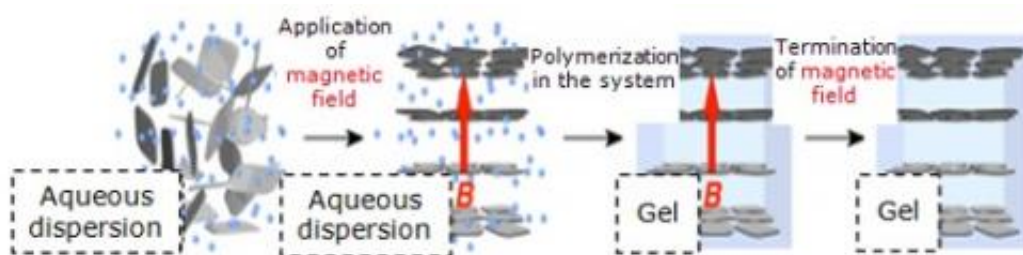


Figure 3 in the press release. Under a magnetic field, radical polymerization of vinyl monomers can proceed to produce hydrogel material whose structure is supported from inside by an electrostatic repulsive force. This process then causes the conversion of aqueous dispersion containing nanosheets into hydrogel. The structure of hydrogel, in which nanosheets are arranged in a parallel orientation, will be fixed semipermanently. Credit: NIMS

A joint research group successfully developed a material that expresses a unique mechanical property by arranging oxide nanosheets, that electrostatically repel each other, in the direction perpendicular to a magnetic field, and by confining a three-dimensional nano-network structure in a water-swollen gel material, hydrogel.

Devices that take advantage of electrical and magnetic [repulsive forces](#) include linear motors and magnetic bearings. These devices are capable of performing special functions due to the use of repulsive force in

addition to attractive force. In contrast, structural materials such as ceramics and plastics had been strengthened by increasing the [attractive force](#) between their components as exemplified by the hybrids between organic polymers and inorganic particles. No attempt had been made to utilize repulsive force in designing structural materials. On the other hand, articular cartilage in animals is made of negatively-charged high-density polymers, and its high load bearing capacity and high wear resistance are attributed to the electrostatic repulsive force.

The joint research group between RIKEN and NIMS discovered that when a [magnetic field](#) was applied to the polyanionic titanium oxide nanosheets that are dispersed in water, all of the sheets turned to a position perpendicular to the magnetic field, and a huge, anisotropic electrostatic repulsive force was generated between the nanosheets arranged in a face-to-face orientation. The process of gelling the aqueous dispersion produces hydrogel material whose structure is supported from inside by an electrostatic repulsive force. Unlike ordinary materials, this material demonstrates a unique mechanical property of withstanding large loads applied vertically to it while easily distorting in the horizontal direction. As such, it performs outstandingly as a vibration-damping material.

This discovery illustrated that repulsive force, to which virtually nobody had paid attention, is extremely useful in controlling mechanical properties of structural materials, and may cast great influence on the designing of [structural materials](#) in the future.

This study is published in the UK scientific journal *Nature*.

More information: "An anisotropic hydrogel with electrostatic repulsion between cofacially aligned nanosheets". *Nature* 517, 68–72 (01 January 2015) [DOI: 10.1038/nature14060](https://doi.org/10.1038/nature14060)

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