National Aeronautics and
Space Administration

technology solution

Materials and Coatings

Large Strain Transparent Magneto-active Polymer Nanocomposites

For use in unmanned aerial vehicles, deployable antennas, sateliite structures, switches, and valves

Actuators and smart materials which respond to external stimuli such as electric field, magnetic field, light, and thermal energy, are being developed at NASA's Glenn Research Center. These materials can be used in space deployable structures, as well as in unmanned aerial vehicles, deployable antennas, satellite structures, and temperature-sensitive switches and valves. Glenn's novel materials enable the remote actuation of a magnetic polymer nanocomposite by a magneto-static or electromagnetic field. This enables mechanical manipulations of structural components remotely and wirelessly, which can be critical in extreme environments. Glenn's super-paramagnetic polymer nanocomposite actuator films are prepared by addition of super-paramagnetic nanoparticle into the polymer films, both thermoplastic elastomer (TPU) and high stiffness polyimide resin. The TPU magnetic nanocomposites are called soft magneto-active materials and polyimide magnetic nanocomposites are called hard magneto-active nanocomposites.

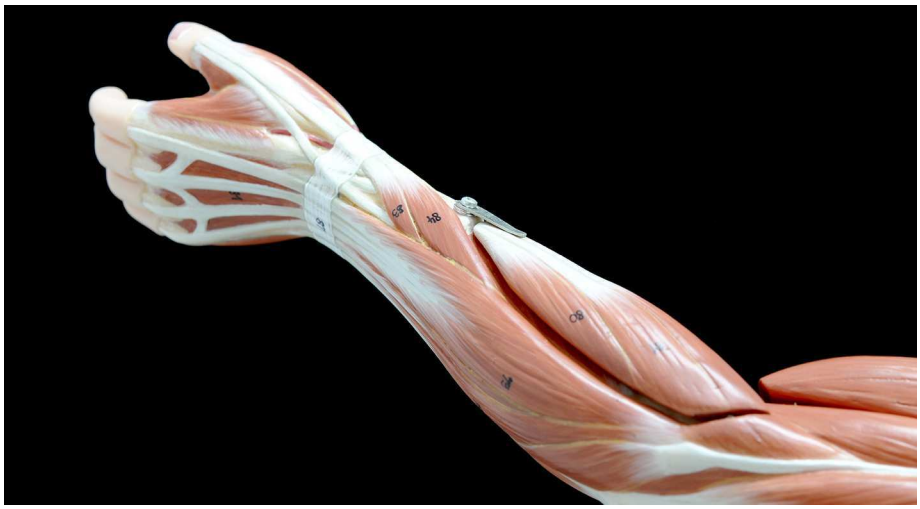
BENEFITS

- High performance: Large deformation with low loading level
- Versatile manufacturing: Can be processed by injection molding, extrusion, or solvent casting
- Good dispersion of magnetic nanoparticles: Transparent to semi-transparent in the visible wavelength range

THE TECHNOLOGY

NASA Glenn's polymer nanocomposite super-paramagnetic magnetic actuators were prepared by addition of organically modified super-paramagnetic nanoparticles to the polymer matrix. The nanocomposite films exhibited super-paramagnetic behavior, which increased with increasing nanoparticle loading. The magnetic polymer nanocomposite films exhibited large deformations under a magneto-static field with a low loading level of 0.1wt% in a thermoplastic polyurethane elastomer (TPU) matrix. The maximum actuation deformation of the nanocomposite films increased exponentially with increasing nanoparticle concentration. The cyclic deformation actuation of a high loading magnetic nanocomposite film was examined in a low magnetic field and exhibited excellent reproducibility and controllability. Low loading TPU nanocomposite films (0.1 - 2 wt%) were transparent to semi-transparent in the visible wavelength range owing to good dispersion of the magnetic nanoparticles. Magneto-actuation phenomena was also demonstrated in a high modulus, high temperature polyimide resin with less mechanical deformation.

This is an early-stage technology requiring additional development. Glenn welcomes co-development opportunities.



Glenn's new generation nanocomposites may be used for artificial muscles

APPLICATIONS

The technology has several potential applications:

- Aerospace structural components
- Deployable antennas
- Satellite structures
- Micro-robotics
- Artificial muscles
- Temperature-sensitive switches and valves

PUBLICATIONS

Patent No: 9,331,607

Patent Pending

More Information

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NASA's Technology Transfer Program pursues the widest possible applications of agency technology to benefit US citizens. Through partnerships and licensing agreements with industry, the program ensures that NASA's investments in pioneering research find secondary uses that benefit the economy, create jobs, and improve quality of life.

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