Press Releases

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Novel ER Fluids to Make Clutches

Scientists at the Hong Kong University of Science and Technology have developed a new class of electrorheological (ER) fluids whose commercialization, into eco-friendly clutches, will provide a significant technological boost for the automotive industry.

This new generation of ER fluids breaks the world record for the solid strength of ER fluids. The fluids are capable of exhibiting a high yield stress (the strength of the materials in solid state) of 130 kPa when electrically charged, 10 times stronger than the previously achievable ER solid strength.

The breakthrough was published in the 5 October issue of *Nature Materials*, a member journal of the prestigious *Nature* series. The referee's report commented that the HKUST paper "represents a significant advance in the development of ER fluids," and "may revive some of the commercial interest in the technology".

When electrically charged, an ER-based clutch is strong enough to lift 40 kg weight off the ground

Such fluids and their unique properties have been recognized for more than 50 years, but practical applications had yet to be developed because until now researchers had been unable to break the 20 kPa barrier.

ER fluids are "smart" materials consisting of dielectric microparticles dispersed in an insulating liquid, usually silicone oil. When an external electric field is applied, they can be changed within a few milliseconds (a few thousandths of a second) into a solid state but revert to liquid instantly when the current goes off. This process, called electrorheology, is reversible.

The extraordinary properties of ER fluids make them ideal materials to transfer energy and control motion electronically, particularly in the automotive industry. When coupled with sensors, ER fluids become "smart" by being able to respond nearly instantaneously to environmental variations, thus opening the vast potential of active mechanical devices such as vibration dampers, shock absorbers, brakes, clutches and valves.

An ER-based clutch

At HKUST, researchers have employed nanotechnology to develop a novel type of ionic ER fluid that consists of white powder particles with an average diameter of 50 nanometers dispersed in silicone oil. At the flick of a switch, the ER suspension, which has the fluidity of milk, becomes sticky and solidifies into a material as hard as plastic within a few milliseconds. Researchers have used the fluids to create a new type of clutch that could replace mechanical gears.

"Without the need for friction to transmit torque, there will be little wear and tear, or noise for our ER-based clutch, making it an eco-friendly product with a faster response time, and a

longer lifespan than conventional designs," says Dr Weijia Wen, Assistant Professor of Physics at HKUST. He is joined by Xianxiang Huang, a PhD student at HKUST, Dr Shihe Yang, Associate Professor of Chemistry, Prof Kunquan Lu from the Institute of Physics of the Chinese Academy of Sciences, and Prof Ping Sheng, Head of the Department of Physics.

As a first step towards commercialization, the research team is working with the China Patent Investment Ltd to develop potential applications for the ER fluids. An ER-based mini-clutch for use in motorized bicycles is expected to be ready in early 2004. The project is partly sponsored by the Small Entrepreneur Research Assistance Programme of the Innovation and Technology Commission.

The research team: (from left) Dr Shihe Yang, Dr Weijia Wen, Prof Ping Sheng and Xianxiang Huang

With support from the Research Grants Council and the National Natural Science Foundation of China, HKUST has been conducting research on ER fluids since 1995. The recent breakthrough was a joint effort by the Department of Physics and its Institute of Nano Science and Technology, and the Department of Chemistry.