Scientists develop nanofluid-based materials for impact absorption and passive sensors

December 14 2016

Assistant of the Molecular Physics Department A.Belogorlov - one scientists who research smart nanofluidic materials. Credit: National Research Nuclear University

Experts of the National Research Nuclear University MEPhI (Russia) are developing new smart nanofluidic materials that will enable manufacturing more advanced sensors, detectors, dampers, valves and tactile devices for the automotive and aerospace industries, robotics, healthcare and for the manufacturing of individual protection systems.

Smart nanofluidic materials are hybrid materials consisting of a disordered nanoporous environment and non-wetting liquid or gel. Currently, experts are actively studying the "smart potential" of these substances at laboratories all over the world. This will make it possible to eventually develop sensors, actuators and elements that convert mechanical energy into electrical energy.

Processes in porous environments interacting with liquid or gas are widely used in many modern key technologies, such as catalytic fuel technologies, gas diffusion and liquid purification. All these applications are based on recently discovered properties of systems involving nanoporous environments and non-wetting liquids.

Experts of the National Research Nuclear University MEPhI have discovered that the rapid build-up of external pressure that fills pores with liquid causes pressure inside the system to stop growing and to become fixed. At the same time, small changes in the amount of pressure cause large-scale changes in volume.

Based on generally accepted definitions, this system can be listed among smart materials capable of significantly changing their specifications and independently regulating the extent of their response to new conditions.

Scientists have established some other unusual properties of systems featuring non-wetting liquids and nanoporous environments. These properties make it possible to use such systems in devices for the absorption of explosions, impacts and vibrations. Experts have proven that this system boasts a high energy absorption capacity.

According to department head Vladimir Borman, such a system makes it possible to absorb impact and to reduce the force affecting the protected object ten-fold. The system responds to increased impact energy by more actively filling in pores under constant pressure and by increasing impact-absorption duration. At the same time, pores are filled with viscous liquid in several thousandths of a second.

This filling speed exceeds the estimated levels of traditional hydrodynamic concepts several dozen times over. It turns out that the filling speed does not depend on the liquid's viscosity.

"The virtual absence of heat radiation during impact absorption is another unusual and important response of the system. This is what makes the system we are observing so different from other systems, and this also simplifies the task of developing new repeated action devices," said the scientist.

MEPhI experts have discovered another unique phenomenon: the transfer of a non-wetting liquid, dispergated inside a nanoporous medium, into a "wetting state"; the abnormally slow relaxation of this state and the high temperature sensitivity of this transfer process.

Scientists are confident that non-wetting liquid-disordered nanoporous medium systems will have applications for passive robotic sensors, self-regulating medicine dispensers and impact dampers, such as gloves consisting of smart nanofluidic materials, the surface of which can adhere to a ball without any recoil. Individual protection systems that absorb the energy of an explosion can also be designed using these systems.

Provided by National Research Nuclear University

Citation: Scientists develop nanofluid-based materials for impact absorption and passive sensors (2016, December 14) retrieved 23 June 2024 from https://phys.org/news/2016-12-scientists-nanofluid-based-materials-impact-absorption.html