Buckle up for more big news from InSPACE's nano-world

December 10 2014, by Mike Giannone

European Space Agency astronaut Frank De Winne, Expedition 20 flight engineer, performs another two runs of the InSPACE-2 study, activating the Microgravity Science Glovebox and powering on the hardware in the Columbus module of the International Space Station. Credit: NASA

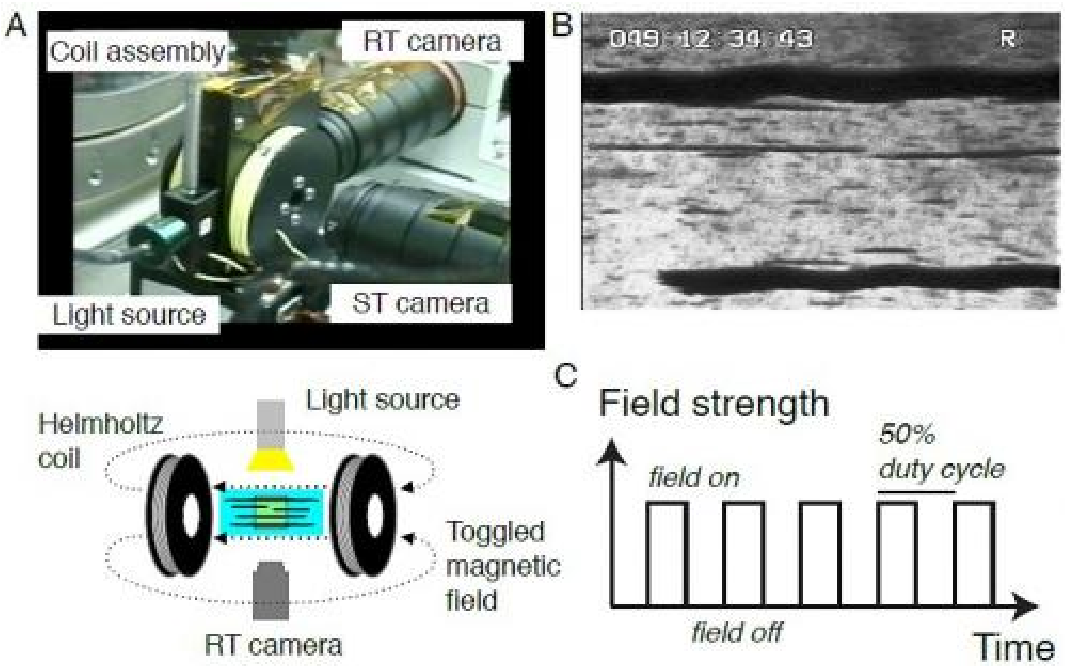
They say good things come in small packages; sometimes so do exciting new discoveries.

From research into things that are one-billionth of a meter in size, near limitless engineering applications could result. Known as nano-particles, understanding these tiny items could result in new materials and manufacturing models, better energy producing systems, improved or new mechanical systems, enhanced films, fiber optics and other soft materials.

The Structure of Paramagnetic Aggregates from Colloidal Emulsions (InSPACE) series of experiments on the International Space Station explored nano-particles suspended in Magnetorheolocial (MR) fluids—a type of smart fluid that tends to self-assemble into shapes in the presence of a magnetic field. InSPACE research is supported by NASA's Space Life and Physical Sciences Division, which oversees space station research into basic and applied scientific studies in life and physical sciences.

Emerging from the InSPACE-2 investigation are findings that clarify details, confirm facts and sometimes surprise researchers.

The article titled 'Buckling Instability of Self-Assembled Colloidal Columns', published in the American Physical Society's *Physical Review Letters* on Sept. 26, 2014, is just the latest paper written by InSPACE researchers based on space station experiments. It explains the unexpected bucking phenomenon first observed in InSPACE-2.



(a) Position of the columns in the magnetic field. (b) View of the structures that form after toggling the field. Condensed colloidal columns are the dark regions. (c) The field is toggled on and off for more than one hour. Credit: NASA

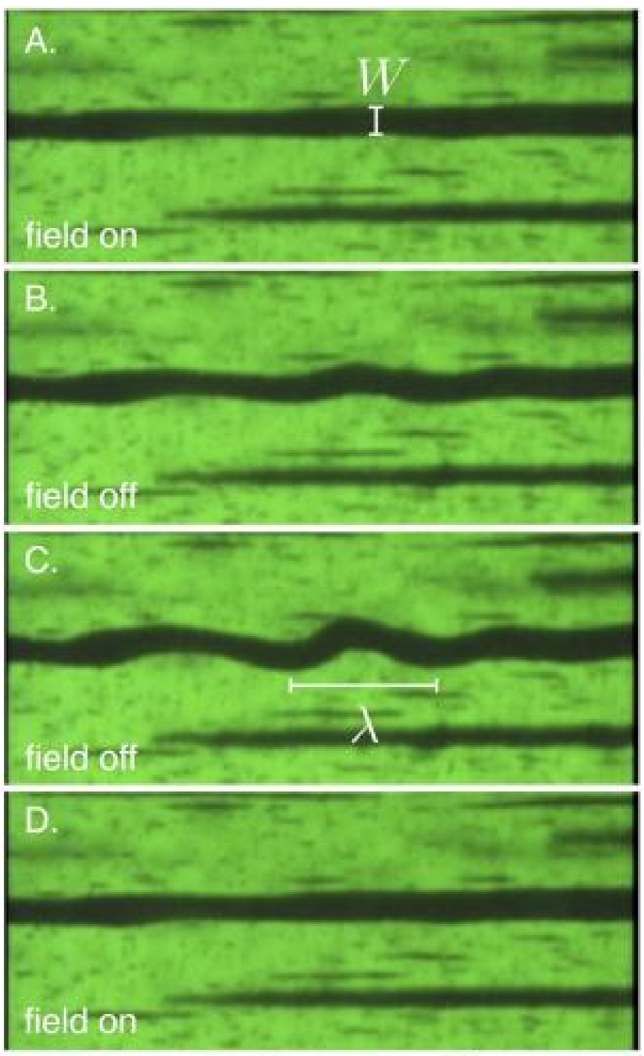
When exposed to magnetic fields, MR fluids can transition into a nearly solid-like state. When the magnetic field is removed, the fluids disassemble and buckle. While the disassembling was expected, the buckling was something that surprised Eric Furst, Ph.D, principal investigator and a 20-plus-year veteran of colloidal research.

"We had never seen anything like this buckling in ground-based experiments," said Furst, of the University of Delaware, Newark.

Buckling is seen—and properly designed to avoid—in buildings and mechanical devices. However, this property had not been observed in MR fluids or more generally, in colloidal soft matter systems before now.

"There's a growing interest in buckling phenomena in terms of manipulating, in particular, soft materials," said Furst. "Whether we want to induce bucking or not, I'm not sure. That's the engineering question we have in front of us. What can we do with this really beautiful, physical, fundamental result?"

With the InSPACE experiments, the idea is to understand the fundamental science around directed self-assembly. Researchers hope to better define new methods of manufacturing materials composed of small colloidal or nano-particle building blocks.



A column in its (a) Unbuckled, magnetic field-on state. (b) Growth of the buckling when the field is toggled off. (c) The maximum deflection. (d) The column again unbuckles as the field toggles on. Credit: NASA

"This is a fundamental experiment to develop techniques that could potentially make new materials that cannot be fabricated using conventional methods," said Bob Green, InSPACE project scientist, at NASA's Glenn Research Center in Cleveland. "With directed self-assembly, you can manipulate the structure of a material on a nano-scale in such a way as to form a new material that has unique properties."

The work done on the space station with InSPACE is part of the research effort to understand materials and give us, what Furst calls, the "magical" devices around us.

"Pick up your phone," said Furst. "Pick up the battery in your phone. The glass on your phone. The materials that thing is constructed of are part of the magic that makes this compact, everyday device that gives us access to the Internet and each other wherever we are. It's all that magic."

There may still be plenty of "magic" that comes out of space station research. There's certainly still plenty of information to mine from the InSPACE studies. That work continues as Furst and those who worked on InSPACE delve deeper into the test results.

Provided by NASA