# *News Release*

## Defense Advanced Research Projects Agency

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**DARPA PROGRAMMABLE MATTER PROGRAM COMPLETES KEY MILESTONES**

The Defense Advanced Research Projects Agency (DARPA) has successfully completed key research milestones in the first phase of the Programmable Matter research program.

DARPA funded five university research teams that are using diverse scientific approaches to demonstrate that macroscopic, three-dimensional solid objects can theoretically be constructed and disassembled using mesoscale particles with manufacturable properties.

The overall goal of DARPA's Programmable Matter program is to develop new forms of material that can reversibly assemble into complex, functional three-dimensional objects upon external command. If successful, programmable matter could greatly simplify a warfighter's needs by increasing flexibility and reducing weight and volume burdens.

DARPA's vision for Programmable Matter is a material that can perform several operations in sequence: upon activation by an external signal, decode and propagate instructions; translate information into action, transport particles and assemble shapes; interlock particles to form an object; perform error-checking and encode final state information, again activated by external signal; and disassemble into the starting material.

"The concept of creating dynamic new materials that reversibly change their fundamental properties on demand offers the potential for revolutionary new capabilities for our men and women in uniform," said DARPA Program Manager Mitchell Zakin, Ph.D. "Imagine the possibilities: an entire toolbox originating from a single material form, or flexible clothing or equipment that can adapt to the immediate and changing needs of the warfighter, perhaps even 'smart' bandages embedded with diagnostic sensing capabilities. The possibilities are endless, and so we have decided to move into the 18-month-long second phase of this program."

In the recently completed first phase of the Programmable Matter program, researchers built mathematical models that theoretically confirmed at least one viable procedure for constructing and disassembling macroscopic three-dimensional solid objects under external command. Researchers also successfully demonstrated critical technological elements of their approach.

The five research teams are pursuing a variety of scientific approaches. The Harvard University team of researchers led by Professor George Whitesides is developing a sort of

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"generalized Rubik's Cube" that acts as a central organizer to encode information and assemble matter. Professor David R. Liu's Harvard team is relying on DNA base pairing as a sort of molecular Velcro to program the assembly or disassembly of "smart" materials. At the Massachusetts Institute of Technology, Professor Daniela Rus has created an innovative computational origami of two- and three-dimensional functional structures, through the "folding" of matter. Also based at Massachusetts Institute of Technology, Professor Neil Gershenfeld's team is pursuing a concept called "milli-biology," in which digital components are employed to engineer mesoscale analogs of biological structure and function. At Cornell University, Associate Professor Hod Lipson's team is using jamming to create extreme strength in materials that are assembled using enzyme-mimetic building blocks of matter.

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