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Corps Laboratory Partners with Industry to Advance Silicon Nanoparticle Applications

The U.S. Army Engineer Research and Development Center (ERDC) and NanoSi Advanced Technology, Inc. signed a Cooperative Research and Development Agreement to co-develop matrix embedded fluorescent silicon nanoparticles (Si-NP). This three-year basic research program seeks to validate relationships between the Stokes shifted Si-NP fluorescence peak and macro-level strain state. Advancing this state of science could pave the way for development of self-diagnosing and sensing, multi-functional materials.

"The term 'Stokes shift' refers to the longer wavelength of electromagnetic energy emitted as a result of losing some absorbed energy," said Dr. Charles Marsh, project leader at ERDC's Construction Engineering Research Laboratory (CERL) in Champaign, Ill. "We want to show, among other things, that the fluorescence emission wavelength at peak intensity will have a Stokes shift that depends on deformation of the embedded Si-NPs."

ERDC-CERL is a Corps of Engineers research laboratory with a mission to acquire, build, operate and maintain military facilities affordably and sustainably. If they emerge successfully, the Si-NPs could have numerous potential applications in both military construction and civil works structures.

NanoSi is a Champaign-based company that specializes in producing Si-NPs in the 1- to 4- nanometer range. "The company is developing nano solar devices for energy harvest and storage as well as devices for sensing biomedical substances such as glucose," said NanoSi vice-president Gary Shaw.

"These materials have unique, potentially useful fluorescent properties in the visible spectrum when excited by ultraviolet radiation," said NanoSi president Dr. Munir H. Nayfeh, who is also a physics professor at the University of Illinois, Urbana-Champaign.

According to Marsh, "The ultimate goal would be to embed them in materials directly or via a tightly adhered coating -- an I-beam, for example -- to remotely interrogate the structure using UV light and determine the local state of strain."

Another ERDC-CERL researcher, Dr. Ghassan Al-Chaar, said these sensors have the potential to be used in extreme pressure environments.

Examples include placing them within deep water structures, using them to monitor earthquake fault movements, and using them in high hydrostatic pressure areas such as submarines and in high atmospheric pressure areas such as airplanes.

Development of the Si-NP is being funded as a basic research project by the U.S. Army.