SYMPOSIUM ON BUILDING BLOCKS FOR FUTURE SPACE EXPLORATION AND DEVELOPMENT (D3)
Novel Concepts and Technologies to Enable Future Building Blocks in Space Exploration and Development (3)

Author: Ms. Sumitra Rajagopalan
Bioastra Technologies, Canada

SMART PUTTY IN SPACE: INTELLIGENT, ADAPTABLE AND PROGRAMMABLE MATTER AS BUILDING BLOCKS FOR FUTURE SPACE EXPLORATION

Abstract

Intelligence and Autonomy have always been important bywords in the design of space technologies and systems. Indeed, the need to resist hostile and unpredictable environments, stay robust and functional without the benefit of regular maintenance and to evolve to meet increasingly-complex requirements of various space missions, necessitates the design of highly sophisticated materials and structures.

Over the past few years, they have been tremendous progress in the field of so-called "smart",reflexive materials that suddenly transform into new configurations or functionalities in response to a trigger in their immediate environment. The first-generation of such smart materials such as nitinol wires, memory foams, switchable oxides and piezoelectric wires have already been tested, many successfully, in simulated space environments.

This paper will focus on the transformational impact of the next generation of smart materials that go by the moniker of "smart putty": Intelligent, programmable matter that configures or reconfigures into virtually any shape, structure or function in response to a deliberate or environmental trigger. What was once considered science fiction is becoming a distinct possibility with the advent of Stimuli-Responsive Polymer Nanocomposites that combine the sheer versatility of stimuli-responsive graft copolymers with the unprecedented mechanical and functional properties of nanoscale fillers such as nanocrystalline cellulose, graphene and modified nanoclays.

Mreover,smart putty displays unique sol-gel properties that make them an ideal candidate for 3D additive printing and assembly of structures in space.

This paper puts forward a thesis that Smart Putty will literally - form the building blocks of future space architectures and systems with broad-based applications from reconfigurable robotics and "bionic" human interfaces to self-powered systems and smart micro-climactic control.

This paper will initially paint a picture of a futuristic space system conceived entirely out of adaptive, programmable matter to introduce the concept of smart putty. The paper will then dwell on the fascinating chemistry and mechanics of these materials and offer video demonstrations of various smart putty prototypes and their earth-based applications.

Having captured the imagination of the audience with the endless possibilities of smart putty, this paper will close with a comprehensive technology roadmap over the next 10-15 years to design and space-qualify programmable materials against performance requirements of increasing complexity.

Space exploration has inspired generations bygone and the author sincerely believes that these futuristic and fascinating materials will not only transform space explorations and architectures but also inspire a new generation of engineers and explorers in the decades to come.