NEW MEXICO EPSCOR: STRUCTURAL HEALTH MONITORING AND SELF-HEALING OF AEROSPACE STRUCTURES

Progress Report

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October 1, 2007- September 30, 2008

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Grant Number NNX07AT64A

Three new approaches are being pursued for structural health monitoring and damage repair of aerospace structures. The first is to treat SHM as a comprehensive, multi-scale phenomenon in which damage detection may be needed over a spectrum of length scales from the microscopic to the macroscopic (Butcher, Sevostianov, Zagrei). The second approach is attributing to damage in joints and connections an importance: commensurate with fracture and fatigue damage that develops in the structural material (Burton, Butcher, Sevostianov). The third approach is to develop material self-healing systems (SHS) capable of repairing material damage while: maintaining structural integrity (Bakhtiarov). The research outcomes will be useful for many aerospace structures, including aircraft structures and engines, launch vehicles, space vehicles, permanent structures placed on the moon or Mars, and robotic devices that patrol these structures for SHM.

Progress in first 9 months: 1) developed analytical methods, based on structural vibration properties to separate joint/connection damage from interior material damage; 2) developed results in micromechanics that improve ability to assess interior material damage directly and by using cross-property connections: 3) developed a self-healing thermal barrier coating for high temperature applications (jet engines, gas turbines, combustion chambers, etc.) - tests demonstrated significant thermal activated self-healing potential; 4) nonlinear impedance SHM method has shown promising results in aluminum specimens with fatigue cracks: in addition, recent studies have focused on issues related to embedded sensor installation and self-diagnostics.

Publications (in press and submitted) attributed to the project:

Butcher, E.. A., I. Sevostianov, and T. D. Burton, “On the separation of internal and boundary damage from combined measurements of electrical conductivity and vibration frequencies,” *International Journal of Engineering Science*, in press.

Kushch, V.I., Sevostianov, I., and Mishnaevsky, L. Stress concentration and effective stiffness of aligned fiber reinforced composite with anisotropic constituents, /International Journal of Solids and Structures/ (in press)

Sevostianov, I., Kushch, V.I., Effect of pore clusters on the statistics of peak stress and overall properties of porous material (under review)

Sevostianov, I. and Kachanov, M. On elastic stiffness and conductivity of contacting rough surfaces (under review)

Butcher, E., Sevostianov, M Sari, and M. Al-Shudeifat, “Use of Nonlinear Vibration Frequencies and Electrical Conductivity Measurements in the Separation of Internal and Boundary Damage in Structures, “ Proc. IMECE2008, Nov., 2-6, 2008, Boston, MA (submitted)

Al-Shudeifat, M.A., E.A. Butcher, and T.D. Burton, “Comparison of order reduction methodologies and identification of NNMs structural dynamic systems with isolated nonlinearities,” Proc. IMAC2009, Orlando, FL (submitted)