

MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Smart Materials and Adaptive Structures (5)

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MULTI-FUNCTIONAL PIEZOELECTRIC SPACE VEHICLE STRUCTURAL SYSTEM

Abstract

The great tragedy of space shuttle Columbia was a consequence of an unknown structural damage as the heat shield was missing on the bottom of the space shuttle. The health of a space vehicle is of great importance in a space mission. The vibration suffered by the space structural system puts the space vehicle in lot of risk. To control the vibration suffered by the space vehicle structure helps to make the space mission safer. The shape control of a space vehicle is also very important. The usage of smart materials in space vehicle structure has helped to minimize the risk of a space mission. The above given three requirements for spacecraft and the launch vehicle system for future space mission can be accomplished by using the smart material known as the Piezoelectric Material in the structural system.

The piezoelectric material is a smart material which has a fast electro-mechanical response. The piezoelectric material causes piezoelectric effect which is generation of electricity polarization in a material due to mechanical stress. It is called direct effect. Also, the piezoelectric material has a converse effect that a mechanical deformation will happen if an electric charge or signal is applied. The piezoelectric material can perform both direct and converse piezoelectric effect, thus it can be used as a sensor as well as an actuator. The space vehicle structure can be made using a piezoelectric material according to the surface requirement. The space vehicle surface can be made of piezoelectric ceramic material which could withstand the heat as well as acts as a sensor to detect any kind of mechanical stress in any surfaces due to some space debris collision being a part of vehicle health monitoring system by means of direct effect. The defect can be mend to an extend by passing electric current in opposite polarity which would cause the elongation of material. The structural material embedded with piezoelectric actuators would help in shape control. The control of vibration can be done using piezoelectric material which acts as a sensor and an actuator at the same time, so it has a fast enough response to produce anti-resonance vibration.

The piezoelectric material used as sensor and actuator on the space vehicle surface structural system would help in health monitoring, shape controlling and vibration controlling. The usage of piezoelectric material would make the future space missions safer and efficient.