ABSTRACT TITLE: Resonance Analysis of High Temperature Piezoelectric Materials for Actuation and Sensing

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ABSTRACT

The current NASA Decadel mission planning effort has identified Venus as a significant scientific target for a surface in-situ sampling mission. The Venus environment represents several extremes including high temperature (460°C), high pressure (~90 Atm.), and potentially corrosive (condensed sulfuric acid droplets that adhere to surfaces during entry) environments. This technology challenge requires new actuator and sensor designs that can withstand these extreme conditions. In addition a variety of industrial applications could benefit from an extended temperature operating range of actuators and sensors. Piezoelectric materials can potentially operate over a wide range reaching as low as –270°C to as high as +650°C. Single crystals, like LiNbO3, have a Curie temperature that is higher than +1000°C. In order to investigate the feasibility of producing actuators/sensors that can operate under these conditions we have initiated a study of the properties of a variety of piezoelectric materials in the temperature range 25°C to 500°C. Piezoelectric materials were chosen because they are solid state and can be designed as actuators to provide high torque, stroke, and speed, however the feasibility of this critical actuation capability has never been demonstrated under the extreme conditions mentioned above. We will present our results of our measurements on a variety of piezoelectric materials that can be operated at temperatures above 460°C. The data for small signal resonance analysis (ring, radial and thickness extensional modes) of disk and ring samples made of Bismuth Titanate and $Bi(MgTi)O_3$-$PBTiO_3$ as a function of the temperature will be presented.

KEYWORDS: Curie temperature, piezoelectric response, mechanical Q, Bulk Acoustic Waves Devices

BRIEF BIOGRAPHY: Dr. Stewart Sherrit is a Member of Technical Staff at the NDE and Advanced Actuators (NDEAA) Laboratory at the Jet Propulsion Laboratory. He received the B.Sc., M.Sc. and Ph. D degrees in Engineering Physics from the Physics Department of Queen's University at Kingston. His research areas include ultrasonics, electromechanical materials and novel actuators and sensors for space applications. He has published over 50 articles and has been an invited speaker at International meetings. He is currently chairman of the IEEE Standards Subcommittee on "Characterization of loss in Electromechanical Materials".