tion. The influence of the ultrasonic frequency on LSAW method is also investigated. And the detected results were verified in SEM (Scanning Electron Microscope) detection.

**SMS-04: Research and Development of Multi-Ferroic Materials and Devices for Smart Systems**

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As research of the composite Multi-Ferroic materials and devices of solid transformation type material, the actuator/sensor material using a magnetic property and the superelastic characteristic were studied. A composite actuator material by combining a shape memory alloy and a ferromagnetic material was designed and fabricated because it can be driven with high speed as well as considerably large deflection by a wireless magnetic field. As for the elemental material, a shape memory alloy CuAlMn and a ferromagnetic material Fe were selected and laminated. The following characteristic evaluations were performed. 1) Difference of the material properties and actuator performance between sandwiches structure (SS) and bimorph structure (BS). 2) Strength of the composite material when changing the thickness and elemental ratio of the structured material. 3) Response speed in the alternative magnetic field. Consequently, these results can show the possibility of a new type of composite actuator.

**SMS-05: Development of High Performance CFRP/Metal Active Laminates**

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This paper describes development of high performance CFRP/metal active laminates mainly by investigating the kind and thickness of the metal. Various types of the laminates were made by hot-pressing of an aluminum, aluminum alloys, a stainless steel and a titanium for the metal layer as a high CTE material, a unidirectional CFRP prepreg as a low CTE/electric resistance heating material, a unidirectional KFRP prepreg as a low CTE/insulating material. The aluminum and its alloy type laminates have almost the same and the highest room temperature curvatures and they linearly change with increasing temperature up to their fabrication temperature. The curvature of the stainless steel type jumps from one to another around its fabrication temperature, whereas the titanium type causes a double curvature and its change becomes complicated. The output force of the stainless steel type attains the highest of the three under the same thickness. The aluminum type successfully increased its output force by increasing its thickness and using its alloys. The electrical resistance of the CFRP layer can be used to monitor the curvature to control it.

**SMS-06: Piezoelectric Properties of Sr2.9Ca0.1Na0.9Nb2O7 (SCNN) Ceramics (0.05<X<0.35) for a Smart Patch**

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The study investigating the electrical properties of dense lead-free piezoelectric ceramics in the (1-x)Sr2.9Ca0.1Na0.9Nb2O7-Ca2Nb2O5 (SCNN) system with x ranging from 0.05 to 0.35 is reported here. Materials were produced with Spark Plasma Sintering (SPS) method. Ferroelectric and piezoelectric properties of SCNN greatly depended on the Ca content. The composition with x = 0.15 exhibited the greatest polarization with Pr = 3.0 μC cm⁻² and piezoelectric constant of d33 = 96 pC/ N, whereas the compositions with x = 0.30 and 0.35 almost lost their ferroelectricity and piezoelectricity. Not only investigation of materials properties but also application possibility as a sensor is surveyed. The ultrasonic waves generated by SCNN material as a sensor are much clearer that that by commercially available PZT materials. This study apparently indicates that lead-free SCNN piezoelectric ceramics have potential for electromechanical application.

**TUESDAY AFTERNOON, June 21**

**AWB-01: Effect of Fillet Geometry to Joint Strength of Four-Pipe-Brazed Specimen for Rocket Nozzle Skirt**

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The strength of the brazed joint of the four-pipe-brazed specimen (4PB), which imitates the rocket nozzle skirt's wall, is analyzed numerically. The 4PB specimen comprises four pipes brazed side by side with JIS BP4-6 palladium brazing filler metal. The effect of the fillet geometry to the joint strength of the 4PB specimen is investigated. The numerical analysis is conducted for the 4PB of 10 mm diameter with various root gaps from 0.05 to 3.0 mm and various apparent fillet widths from 1.0 to 4.0 mm. The nominal rupture strain is obtained by the comparison of von Mises' equivalent stress of the fillet and the pipes with their maximum tensile stress. The results show the fracture of the 4PB specimens always occurs at the fillet. The nominal rupture strain tends to have weak correlation with the root gap, but in positive proportion to the apparent fillet width.

**AWB-02: Laser Welding of Dissimilar Metals between AZ31B and A5052-O**

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In case of a combination of dissimilar metals like steel to aluminum alloy, formation of intermetallic layer at the interface can be controlled by...