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| ◆   |  | | --- | | プロジェクト研究報告 ｢大学連携 特異構造金属・無機融合高機能材料開発共同研究プロジェクト活動紹介」 |   ◆ |

Activities in the field of electronics materials development

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. Lead-free piezoelectric ceramic thin films for microelectromechanical system devices

Regulations on the use of materials containing hazardous elements are being promoted mainly in Europe. Currently available piezoelectric ceramic materials are mainly lead-based oxide Pb(Zr, Ti)O3 (PZT) materials, so the development of lead-free piezoelectric materials is an urgent issue. Among various lead-free materials, (K, Na)NbO3 (KNN) has attracted attention as a compound with relatively high Curie temperature and excellent piezoelectric properties. The Ecotopia Science Institute, Nagoya University, has been developing thin films of KNN-based compounds by a chemical process using metal  organic compound precursor solutions, which are highly homogeneous, easy to precisely control composition, and can be synthesized at low temperatures. To control the properties of KNN thin films to obtain desired characteristics, KNN is substituted or doped with different elements. The doping of Mn, which is a multiply charged ion, solves a major problem of reduced electrical insulation. The mechanism is that Mn ions present in the thin film in the Mn2+ or Mn3+ state trap carriers in the film, resulting in improved insulation properties(1). The electric-field-induced induction in KNN-based thin films has been investigated in collaboration with the Nanoscience and Nanotechnology Research Organization (NSRI) of Waseda University.

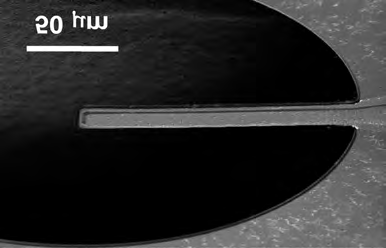


Figure 1 Electron micrograph of a cantilever-shaped (K, Na)NbO3 film after microfabrication.

In such high-temperature environments, there is concern that the performance of semiconductor devices may be degraded, and it is essential to develop more advanced elemental technologies for devices, including bonding technologies. Currently, high-melting point solders (such as Pb5Sn) containing the toxic substance Pb are mainly used for such joints, but with the increase in environmental awareness, the establishment of alternative materials and joint processes that do not contain toxic substances is an urgent issue. Therefore, the Joining and Welding Research Institute, Osaka University, in collaboration with the Nanoscience and Nanotechnology Research Organization, Waseda University, has developed a new solder process that can be used in power devices and other applications that uses high lead content solder.

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| Analysis of various electrical characteristics such as strain characteristics, micro processing, etc. | (Pb5Sn,. | Pn10Sn solder, etc.), and therefore |

The influence of engineering on the properties of these devices is being investigated through the development of a cantilever-type actuator that integrates materials and device fabrication technologies (Figure ), as well as the development of measurement methods for converting natural energy, such as vibration, into electrical energy.

We are working on the establishment of micro joining technology using a new nanoporous structure with the aim of establishing an alternative joining process for Au/Cu and Au/Cu/Au (Fig. ). We have used Au nanoporous materials (Fig. ) fabricated from AuAg alloys, and by controlling the bonding process, Cu/Cu bonding and Au plating/Au plating bonding can be achieved, and high lead-containing solder

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| . | Micro Joining Technology Using Nanoporous Structures | The joint strength of more than 20 MPa, which is equivalent to that of a |

(2)(3).

Increase the efficiency of electric energy and the share of renewable energy

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| Therefore, power modules and energy modules are attracting much attention. | . | Carbon nanotubes for SiC power semiconductors |
| The power module is designed to control the current during operation. Power modules are used to control current during operation. |
| electrode |

The more the current is controlled, the more heat is generated, and the smaller and lighter the module is, the higher the temperature becomes.  
The smaller and lighter the module, the higher the temperature will be due to high-density mounting of components, etc. The SiC surface developed at the EcoTopia Science Institute, Nagoya University, has been used in the development of the SiC module.

 Project Report