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PRESS RELEASE

Source: Toyohashi University of Technology, Japan, Committee for Public Relations

Title: Appearance of anisotropic electrical property in oriented material
Subtitle: Anisotropic *Qf* value was caused by anisotropic electron conductivity and anisotropic bonding strength in the Li-Nb-Ti-O solid solution.

Full text:
In the Li2O-Nb2O5-TiO2 (LNT) system, the LNT forms a unique structure (superstructure). The superstructure is formed by addition of Ti ion and periodical insertion of an intergrowth layer of corundum-type [Ti2O3]2+ in a matrix having a trigonal structure (Fig.1).

To enable the application of this unique structure, The research team led by Prof. Hiromi Nakano fabricated oriented LNT bulk ceramics like a single crystal by slip casting in a strong magnetic field of 12 T.

The research team has spent about 4 years investigating to finally fabricate the high-oriented material. The high degree of orientation was achieved by the good slurries for particle rotation in a high magnetic field. After that, the research team found that the material has anisotropic electric properties along the c-axis in the oriented material. Especially, the *Qf* value parallel to the c-axis was about five times greater than that of perpendicular to the c-axis although εr value did not show an anisotropy in the oriented specimen (Fig.2).

Since a clear answer regarding the relationship between *Qf* and crystal structure has not been reported as yet, Prof. Nakano and her research team members analyzed the material using TEM, XRD, SEM, XAFS and simulation by First-principles calculations. To explain the anisotropic *Qf* value, various factors are evaluated; density, grain size, Ti3+/Ti4+ ion, electrical conductivity, dielectric property, and bonding strength and so on.

As a result, the research team first clarified the mechanism showing that the anisotropic *Qf* value was caused by the anisotropic electron conductivity and the anisotropic bonding strength in the superstructure.

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Mr. Furuya, who is the second author of the article, said, “It is difficult to fabricate the oriented material.” However, he could make good oriented materials. To clarify the mechanism of the anisotropic property, the first author, Prof. Hiromi Nakano continues “I discussed this aspect many times with co-authors and other researchers who are professionals in the field of the micro-wave material. Last year, I went to Finland to discuss the research” Finally, we reached conclusions about the mechanism and the relationship between *Qf* and crystal structure after a five-year investigation.

The mechanism is useful for the material science field and for the design of high-quality micro-wave material. We expect that new material with high- *Qf* would be fabricated based on the mechanism.

The research results were reported in Advanced Powder Technology.

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Reference:
Hiromi Nakano, Shohei Furuya, Motohiro Yuasa, Tohru S. Suzuki, Hitoshi Ohsato (2017), Fabrication and anisotropic electronic property for oriented Li1+x-yNb1-x-3yTix+4yO3 solid solution by slip casting in a high magnetic Field, Advanced Powder Technology, 28, 2373-2379. http://dx.doi.org/10.1016/

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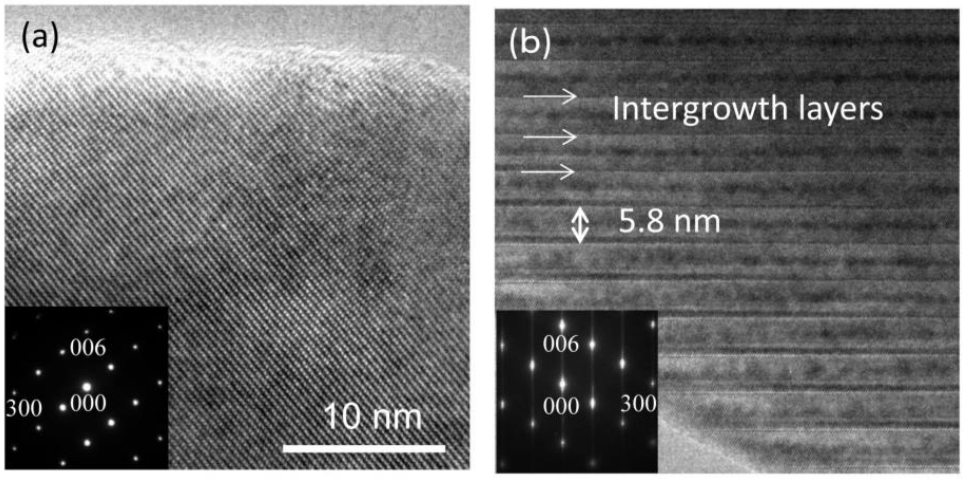
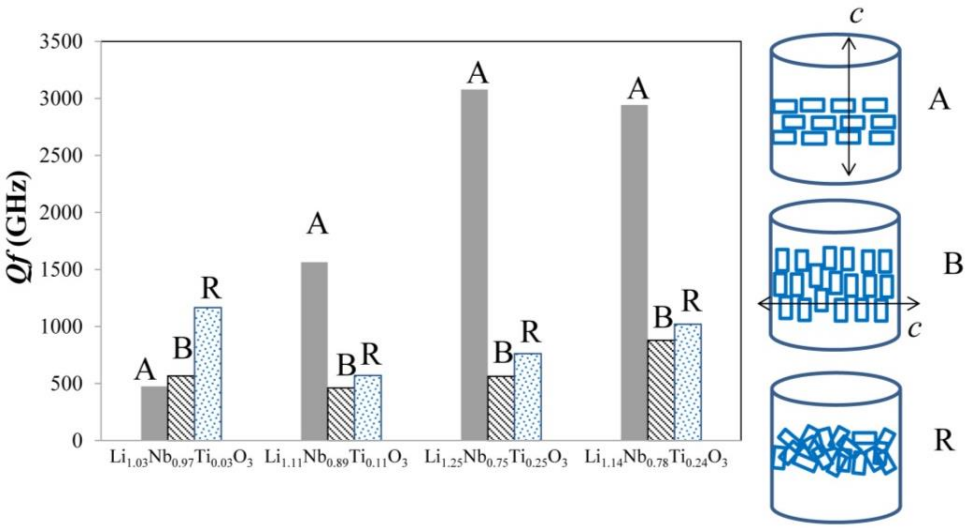
Figure 1:



Caption: The periodical structure forms by diffusion of Ti ion.
(a) Basic structure of Li1.03Nb0.97Ti0.03O3 and (b) superstructure of Li1.25Nb0.75Ti0.25O3.

Figure 2:



Caption: *Qf* values of LNT ceramics parallel to the c-axis in (A), perpendicular to the c-axis in (B). R is random specimen.

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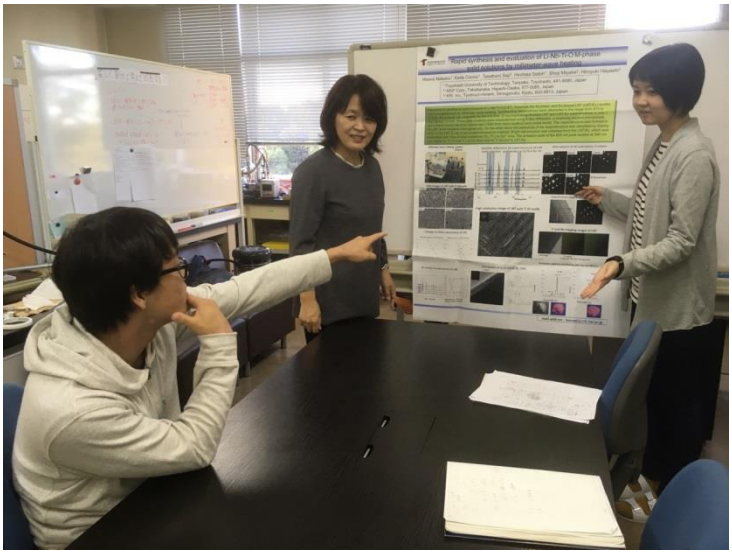
Figure 3:



Caption: Meeting in Nakano Lab with students.

Primary keyword: ATOMIC/MOLECULAR/PARTICLE PHYSICS, CHEMISTRY/PHYSICS/MATERIALS SCIENCES, MATERIALS, PARTICLE PHYSICS