Demonstration of ultra-high speed piezoelectric thin film with nanodomain structure

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The Japan Synchrotron Radiation Research Institute, Tokyo Institute of Technology, the National Institute for Materials Science, and Kyoto University confirmed for the first time in the world that it is possible to achieve ultra-high speed switching in a time of 200 nanoseconds with a new piezoelectric thin film which possesses micro regions called "nanodomains." The new material is expected to enable higher speeds in operation changes (switching).

Piezoelectric thin films utilize the property of structural change in response to electrical signals, and are used as a power source for micro devices (Micro Electro Mechanical Systems, MEMS) in ink jet printers. However, switching time cannot be adequately controlled with the current generation of piezoelectric thin films. If it is possible to realize high speed switching, expansion to industrial applications and development of higher performance products can be expected.

Therefore, using the high brightness synchrotron radiation of Japan's large-scale synchrotron radiation facility SPring-8, this research group investigated the nanodomain structural changes that occur when an electrical field is applied at high speed to a ferroelectric thin film, which is one type of piezoelectric. As a result, the group succeeded in confirming for the first time in the world that the nanodomain crystal orientation of this thin film changes in a time of 2/10 millionths of a second, or 200 nanoseconds (200 ns).

This result, which showed the possibility of controlling piezoelectric thin films at the nanosecond order of 200ns, will make a major contribution to the development of high performance products by realizing higher speeds in MEMS using piezoelectric thin films. As examples, in ink jet printers, achievement of higher treatment speeds in MEMS, which control ink coating, will enable fine printing with a smaller quantity of ink than the conventional technology, and in automotive engines, higher MEMS speeds can be expected to contribute to improved fuel economy and reduced exhaust gas by application of nanodomain structures to ceramic parts which control fuel use efficiency.

This work was published on November 4 in *Applied Physics Letters* and has also been newly selected as a noteworthy paper in the *Virtual Journal of Nanoscale Science and Technology*.

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