Thermoelectric potential distributions of zinc oxide nanowire composites investigated by FM-KFM

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Generally, nanostructured thermoelectric materials exhibit better performance than their bulk crystals. We have been investigating the mechanisms for improving the thermoelectromotive force by analyzing the surface potential distribution using FM-KFM [1]. Figure 1 illustrates our novel sample holder, designed to apply a local temperature gradient to the sample, which features a heater and a liquid−nitrogen cooler. Gold films, which serve as thermal conductors, are deposited on the sample with a narrow-slit gap to generate a large temperature gradient. The surface potential is measured in the slit gap region. In this study, we measured a composite sample consisting of AlZnO films and ZnO nanowires, whose power factor was approximately twice as high as that of the AlZnO films alone. Figure 2 shows the FM-KFM results under the temperature gradient of ~0.8K/μm between the slit. The surface potential was inclined at the facet regions. The application of the temperature gradient affected the surface potential distributions. The slope in the lateral growth region was about four times steeper than that in the vertical growth region. These results suggest that the performance improvements are due to the thermal management effects resulting from the higher Seebeck coefficient and the lower thermal conductivity in the lateral growth regions.

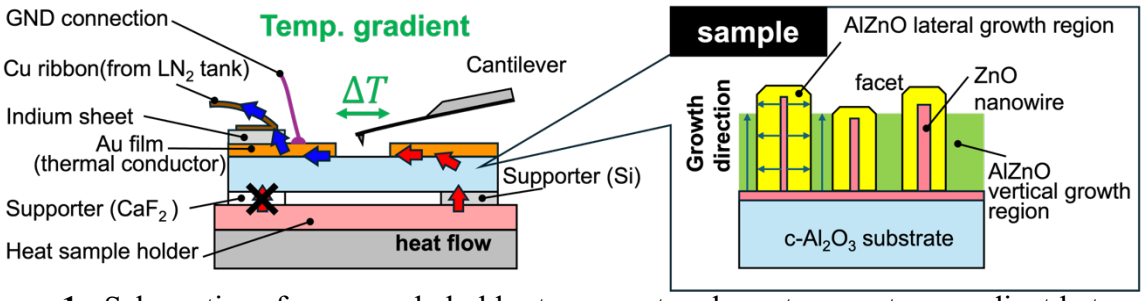

Figure 1. Schematics of our sample holder to generate a large temperature gradient between the narrow-slit gap (100μm) of gold films deposited on the sample surface. The composite sample consisted of ZnO nanowires embedded in AlZnO films, which were fabricated using the pulsed laser deposition method.

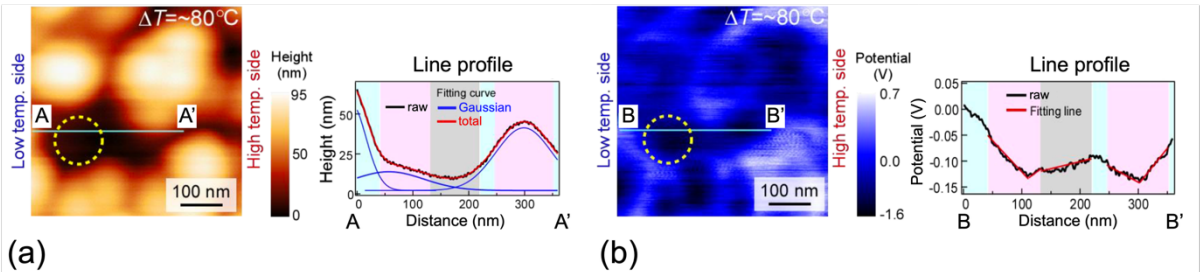

Figure 2. FM-KFM results of the composite sample under the temperature gradient condition. (a)Topographic and (b) surface potential images. In the line profiles, the pink and gray-colored areas correspond to the lateral and vertical growth regions of AlZnO, respectively.

Reference [1] Y. Komatsubara, Y. Miyato, et al. Appl. Phys. Lett. **118**, 091605 (2021).
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