Fabrication of 2D Oxide Nanosheets Structured Ultrathin Capacitors

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The two-dimensional (2D) oxide nanosheets with a wide bandgap have high dielectric properties, and they are single crystals delaminated by chemical exfoliation of bulk layered materials [1]. These crystallites have an approximate thickness of 1 nm and a lateral size of up to 10 µm. Since they can be self-assembled as building blocks, they are promising candidates for applications of next-generation energy storage devices, which need well-organised low-dimensional nanoarchitectures. Studies on Dion-Jacobson type $Ca_2Na_{x-3}Nb_xO_{3x+1}$ nanosheets revealed that an increase in x number will result in an increase in dielectric characteristics according to polar phonon frequency softening [2]. When the perovskite Dion-Jacobson material is synthesised and exfoliated at the maximum x value, new forms of nanosheets with high dielectric properties can be produced. In this study, we have exfoliated Dion-Jacobson-type perovskite layered material of $KCa_2NaNb_4O_{13}$ to obtain the single $Ca_2NaNb_4O_{13}$ nanosheets. The nanosheets were then deposited on ITO flexible substrates grown on PET substrates using the Langmuir-Blodgett technique. The nanosheets structured nanofilms were fabricated by repeating the procedure. Each layer of nanofilms was analysed by the UV-Vis spectrophotometer to confirm the nanofilm growth. The LB nanofilms were patterned by e-beam lithography technique and coated with ITO to develop ultra-thin, flexible, and transparent capacitors. The development of these capacitors will provide new solutions to the miniaturisation problems of silicon-based technologies for flexible display devices.

References

[1] Kosho Akatsuka and Masa Aki Haga and Yasuo Ebina and Minoru Osada and Katsutoshi Fukuda and Takayoshi Sasaki, ACS Nano, 5 (2009) 1097-1106.
[2] Bao Wen Li and Minoru Osada and Yoon Hyun Kim and Yasuo Ebina and Kosho Akatsuka and Takayoshi Sasaki, Journal of the American Chemical Society, 31 (2017) 10868-10874.

Figures

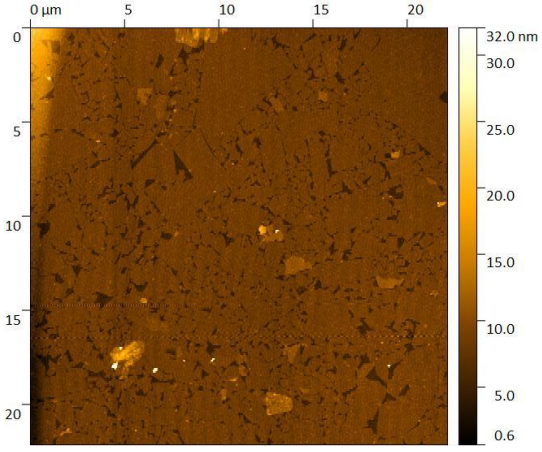

Figure 1. AFM image of LB deposited single $Ca_2NaNb_4O_{13}$ nanosheet monolayer on the silicon substrate