Flexible functional oxides on muscovite via van der Waals epitaxy

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In this presentation, we will discuss some of our recent efforts in developing flexible functional oxides, which might of potential applications in spintronics and multiferroic composites. Four representative functional oxides, namely the highly conductive MoO_2 layers suitable for the base layer in forming heterostructure with other oxides, the fully spin polarized Fe_3O_4, magnetostrictive $CoFe_2O_4$ (CFO) and multiferroic nanocomposite consisting of ferroelectric $BiFeO_3$ (BFO) and ferrimagnetic $CoFe_2O_4$ (CFO), have been deposited on flexible muscovite (mica) substrates via van der Waals epitaxy using pulsed laser deposition technique. The quality of the films grown on mica has been carefully characterized using various analytical tools to demonstrate the viability of preserving their respective intrinsic properties using the present processes. Moreover, the mechanical stability and robustness were tested by cyclic bending test to over 1000 cycles to evaluate their potential usage in flexible oxide electronics.

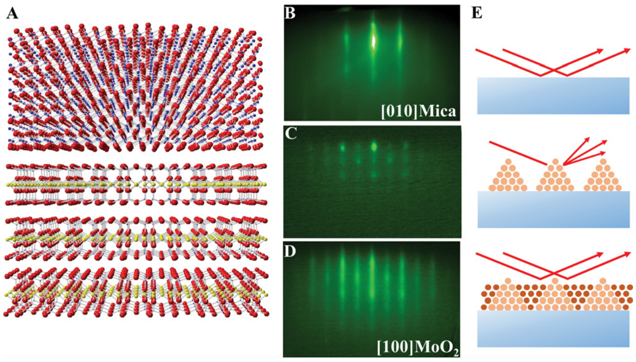

FIG. 1. (a) Schematic representation of van der Waals epitaxial MoO_2 (top, Mo in blue and O in red) on muscovite (bottom, Si in yellow and O in red). RHEED patterns recorded (b) before the deposition, (c) in the early stage of growth, and (d) after the deposition process. (e) Schematic of growth mechanism.

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References:

1. C. H. Ma, J. C. Lin, H. J. Liu, T. H. Do, Y. M. Zhu, T. H. Ha, Q. Zhan, J. Y. Juang, Q. He, E. Arenholz, P. W. Chiu*, and Y. H. Chu*, “Van der Waals epitaxy of functional MoO_2 film on mica for flexible electronics”, Appl. Phys. Lett. **108**, 253104 (2016).
2. H. J. Liu, C. K. Wang, D. Su, T. Amrillah, Y. H. Hsieh, K. H. Wu, Y. C. Chen, **J. Y. Juang**, L. M. Eng, S. U. Jen*, Y. H. Chu*, “Flexible heteroepitaxy of $CoFe_2O_4$/Muscovite bimorph with large magnetostriction”, ACS Appl. Mater. Interfaces **9**, 7297-7304 (2017).
3. T. Amrilla, Y. Bilta, K. Shin, T. Yang, Y. H. Hsieh, Y. Y. Chiou, H. J. Liu, Do Thi Hien, D. Su, Y. C. Chen, S. U. Jen, L. Q. Chen, K. H. Kim, and **J. Y. Juang***, Y. H. Chu*, “Flexible multiferroic bulk heterojunction with giant magnetoelectric coupling via the van der Waals epitaxy”, ACS Nano **11**, 6122-6130 (2017).