RF Reactive Sputtering AlN Thin Film at Room Temperature for CMOS-compatible MEMS Application

W.J. Liu[1, 3], W.J. Xu[2], W.Z. Wang[1], L.M. He[1], J. Zhou[1], Radhakrishnan K[3], H. Yu[3, *], and J.Y. Ren[1, *]
[1] State Key Lab of ASIC and System, School of Microelectronics, Fudan University, Shanghai, China, 200433
[2] Département OAE, Université de Valenciennes, UMR CNRS 8520 – IEMN, Valenciennes, France, 59313
[3] School of Electrical and Electronic Engineering, Nanyang Technological University, Singapore, 639798
*J.Y. Ren: jyren@fudan.edu.cn and H. Yu : aoyu@ntu.edu.sg

AlN are widely used in SAW/FBAR devices, energy harvesting, biosensors, and ultrasonic NDT/fingerprint /microscopy transducers due to its piezoelectricity, good corrosion resistance and thermostability[1]. The preparation of high-quality AlN film plays the key role on the process integration with CMOS circuits for micro system applications[2]. Here, we report an AlN thin film prepared by RF reactive sputtering at room temperature on substrates with different treatments, which is more suitable and economical for CMOS-compatible MEMS fabrication compared with previous works. The AlN thin film was deposited on Si/SiO_2/ Si_3N_4 with different surface roughness which were commonly employed as insulating layers in CMOS circuits. The morphological characterization by AFM and SEM has shown that the AlN thin film was uniform and compact with low roughness and fine grain. The bottom Mo electrode was prepared by DC sputtering at room-temperature. In addition, AlN seed layer from the same sputtering process increased the adhesion between the electrode and the substrate, thereby improved the stability of subsequent processes. In summary, we prepared uniform AlN with few detects by a simple and controllable approach, and this strategy could be potentially applied to COMS-compatible optical and acoustic devices.

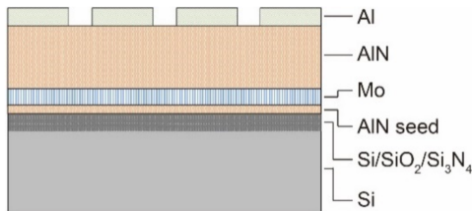

Figure 1. Schematic diagram showing the cross-section of the AlN film with substrate and electrodes

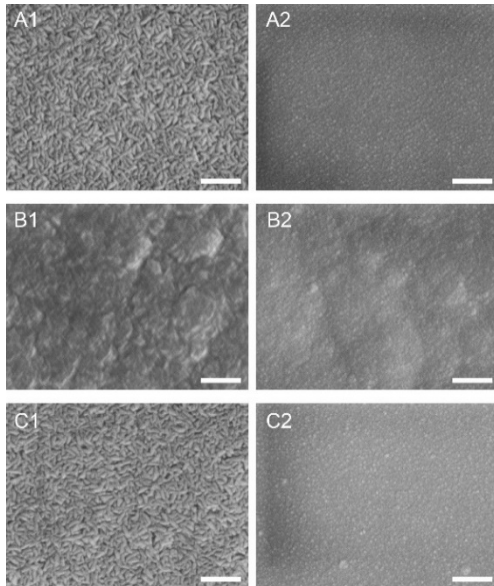

Figure 2. SEM images of AlN films(left) and seed layers(right) on substrates with (A) Pure Silicon, (B) Si_3N_4 by PECVD, and (C) Thermal SiO_2. All the scale bars represent 250nm.

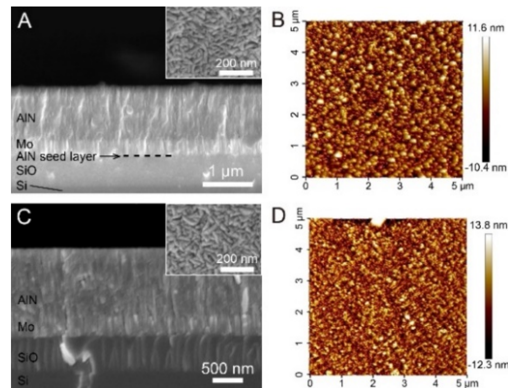

Figure 3. SEM (left) and AFM (right) images of thermal SiO_2 substrate samples with and without AlN seed layer. The dash line in (A) denotes the thin AlN seed layer.

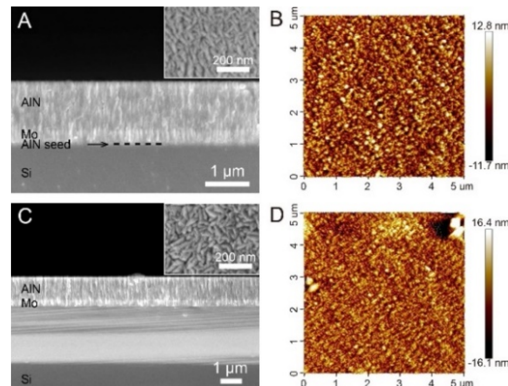

Figure 4. SEM (left) and AFM (right) images of pure silicon substrate samples with and without AlN seed layer. The dash line in (A) denotes the thin AlN seed layer.

References

[1] S. Trolier-McKinstry and P. Muralt, "Thin film piezoelectrics for MEMS," *Journal of Electroceramics,* vol. 12, pp. 7-17, Jan-Mar 2004.

[2] D. A. Horsley, R. J. Przybyla, M. H. Kline, S. E. Shelton, A. Guedes, O. Izyumin*, et al.*, "Piezoelectric micromachined ultrasonic transducers in consumer electronics: The next little thing?," in *2016 IEEE 29th International Conference on Micro Electro Mechanical Systems (MEMS)*, 2016, pp. 145-148.