Optimization of Aluminum Nitride Sensing Film using Magnetron Assisted Pulsed DC Reactive Sputtering

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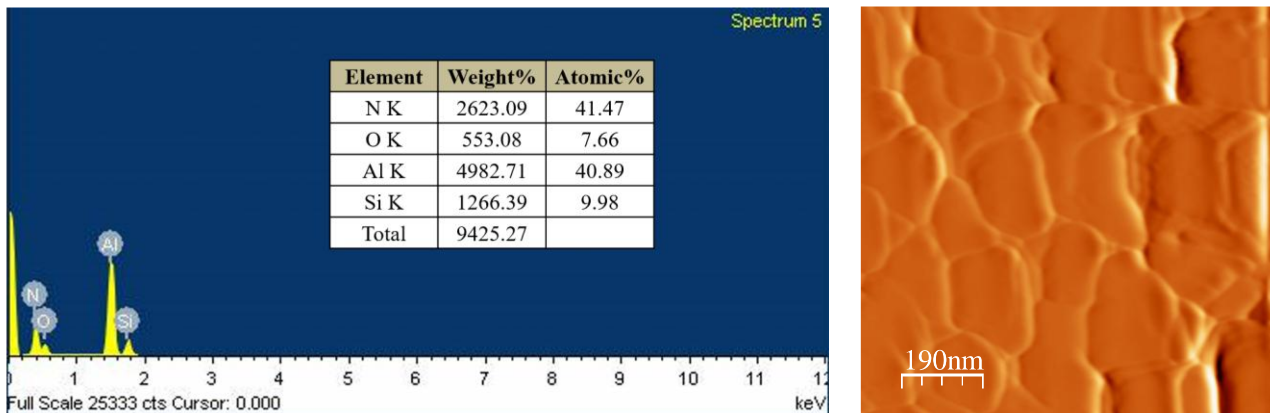
ABSTRACT

Performance of potentiometric chemical/biological sensing platforms largely depends upon the sensing film used to detect the concentrations of ions in an electrolyte [1]. Ion-sensitive Field-Effect Transistor (ISFET) is a popular potentiometric sensor which is commonly used as a pH sensor. In ISFET, silicon dioxide can be used as a sensing film but it is prone to hydration and non-linear sensitivity over the wide pH range [2]. These limitations are addressed by using Aluminum Nitride (AlN) as the sensing film which is deposited using magnetron assisted pulsed DC reactive sputtering [3].

There are various parameters which need to be optimized for depositing AlN film such as operating power, operating frequency, reverse time, operating pressure, substrate temperature, target to substrate distance, and annealing of the film. A detailed study has been carried out to optimize each of the parameters. It was found that higher operating frequency of pulsed DC source gives better stoichiometry of deposited film. Higher operating power leads to faster deposition of AlN thin film. The reverse time should be adjusted according to the frequency of operation such that the duty cycle is kept 70% or less in order to avoid arcing in the target and it also improves the quality of deposited film [3]. Substrate temperature and lower operating pressure leads to better quality of deposited thin film which has lesser voids and granular growth. This is in accordance with Structure Zone Model [4]. Annealing of deposited film also improves the stoichiometry of sensing film. The composition of the deposited film is analyzed using Energy Dispersive Spectroscopy (EDS) as shown in Fig. 1(a). Atomic Force Microscopy (AFM) images of deposited film post annealing is shown in Fig. 1(b). ISFET with AlN as the sensing film was tested as a pH sensor and sensitivity was found to be 33 mV/pH.



Element	Weight%	Atomic%
N K	2623.09	41.47
O K	553.08	7.66
Al K	4982.71	40.89
Si K	1266.39	9.98
Total	9425.27	

Figure 1: (a) EDS analysis of sputtered AlN film, (b) AFM image of deposited film post annealing.

References

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