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Research Article

MODIFICATION AND MORPHOLOGICAL STUDY OF PLASMA ETCHED ALUMINIUM OXIDE THIN FILM

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ABSTRACT
Thin films of alumina were prepared by anodic oxidation of aluminium surface. These films were then treated in plasma of different gases for various duration of time. Plasma treatment was carried out in a plasma reactor using capacitively coupled RF glow discharge. Glow discharge plasma is obtained at a pressure of 0.1 torr. In the present investigation, morphological studies were carried out using Atomic Force Microscope (AFM). For the present work AFM was operated in contact mode. AFM gives more detailed information of surface topography in three dimensions. It also gives statistical data of mean surface roughness. The growth structures of these films were also studied using AFM. Plasma etching was used for removing surface contamination and passivation. The most notable difference between the two images is the change in roughness. The plasma etch had a leveling effect on the surface.

Key Words: *Aluminium Oxide Thin Films, Plasma Etching, Surface Roughness, AFM.*

INTRODUCTION
Disclosed is a process for depositing an aluminum oxide thin film necessary for semiconductor devices. The process includes the steps of: subjecting a gaseous organoaluminum compound as an aluminum source in contact with a target Substrate and depositing aluminum using plasma. The step is sequentially repeated to form an aluminum thin film, and further includes the step of oxidizing the aluminum thin film using plasma of different gases. This deposition cycle is repeated to obtain an aluminum oxide thin film. The present study uses an aluminum source containing less contaminant thus obtaining aluminum oxide of high quality. Furthermore, the temperature of the gas supply and the reactor can be lowered in relation to reduce costs in the fabrication of semiconductor devices (Strohmeir, 1990). Plasma etching is a form of plasma processing in which a high-speed stream of plasmas shot (in pulses) at a sample. **(**Bhat and Joshi (1994)) The Plasma etching process utilizes source gases that dissociate within the plasma, creating a mixture of highly reactive species. The atoms of the shot element embed themselves at or just below the surface of the target. The physical properties of the target are modified in the process. Plasma systems ionize a variety of source gases in a vacuum system by using RF excitations. The frequency of operation of the RF power source is frequently of 13.56 MHz, chosen by the Federal Communications Commission (FCC) for industrial and scientific use. Nevertheless, it can be used lower frequencies (kilohertz) or higher (microwave).The mode of operation of the plasma system change if the operating pressure change.Also, it is different for different structures of the reaction chamber.

MATERIALS AND METHODS
In present study, the experiment was carried out by using anodizing process 99.99% pure Aluminium to obtain porous anodic alumina thin film. **(**Fahy, 1979) The thin film processing can be divided into four parts:
1. Mechanical cleaning by using MgO paste.
2. Chemical treatment of the substrate to remove contamination from the substrate surface.
3. Etching of the substrate surface in NaOH to remove any acidic impurities.
4. Deposition of the thin film on the substrate, by the process of anodic oxidation.

The Plasma Etching process includes the steps of: subjecting a gaseous organoaluminum compound as an aluminum source in contact with a target Substrate and depositing aluminum using plasma.The step is sequentially repeated to form an aluminum thin film, and further includes the step of oxidizing the aluminum thin film using plasma of different gases. This deposition cycle is repeated to obtain an aluminum oxide thin film. The present study uses an aluminum source containing less contaminant thus obtaining aluminum oxide of high quality. Furthermore, the temperature of the gas supply and the reactor can be lowered in relation to reduce costs in the fabrication of semiconductor devices.
Surface studies were carried out for the following samples:
A1: Aluminium oxide thin film formed at 4 mA/cm^2 Etched in Air Plasma for 10 mins, 20 mins & 30 mins.
A2: Aluminium oxide thin film formed at 4 mA/cm^2 Etched in Nitrogen Plasma for 10 mins, 20 mins & 30 mins.
A3: Aluminium oxide thin film formed at 4 mA/cm^2 Etched in Argon Plasma for 10 mins, 20 mins & 30 mins.

RESULTS AND DISCUSSION

To study the topography of Aluminum oxide thin film surface Atomic Force Microscopy is used (Binning *et al.,* 1986). AFM studies were carried out using model Nanoscope III. It is operated in contact mode. AFM gives the statistical data of mean surface roughness and the 3-D image of surface of plasma etched Aluminium oxide thin films.

EFFECT OF AIR PLASMA ON Al_2O_3 FILM: SAMPLE A1

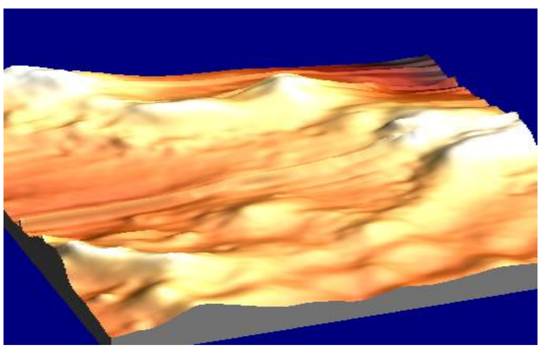

Figure 1: Al_2O_3 Film etched in air Plasma for 10 mins

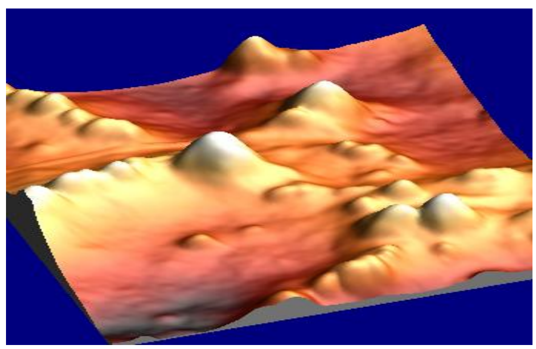

Figure 2: Al_2O_3 Film etched in air plasma for 20 mins.

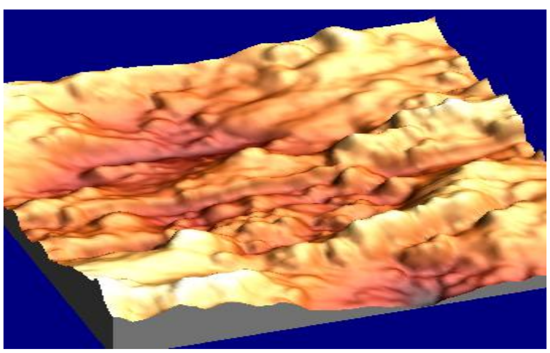

Figure 3: Al_2O_3 Film etched in air plasma for 30 mins.

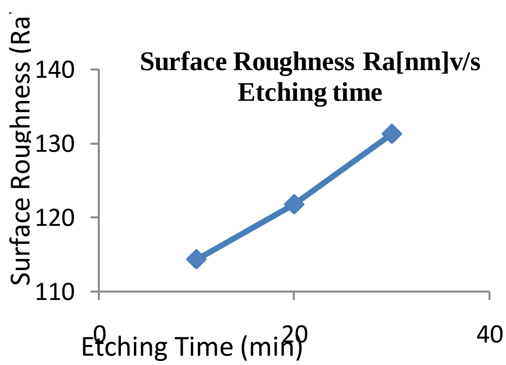

Figure 4: Shows the change in surface roughness of Al_2O_3 Film etched in air Plasma at three different intervals of time.

EFFECT OF NITROGEN PLASMA ON Al_2O_3 FILM: SAMPLE A2

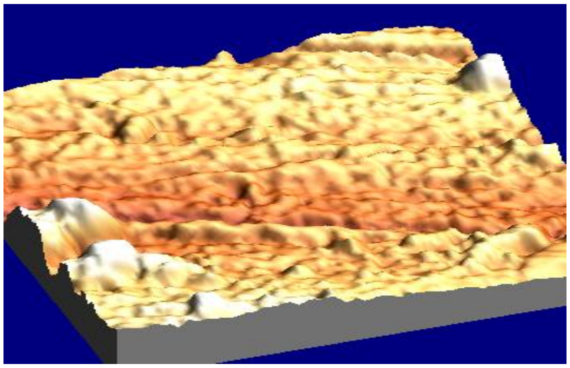

Figure 5: Al_2O_3 Film etched in Nitrogen Plasma for 10 mins.

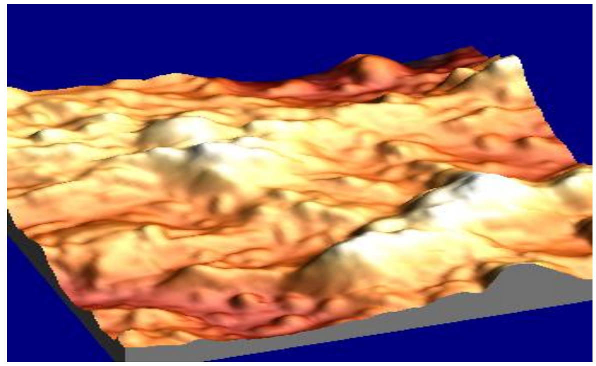

Figure 6: Al_2O_3 Film etched in Nitrogen Plasma for 20 mins.

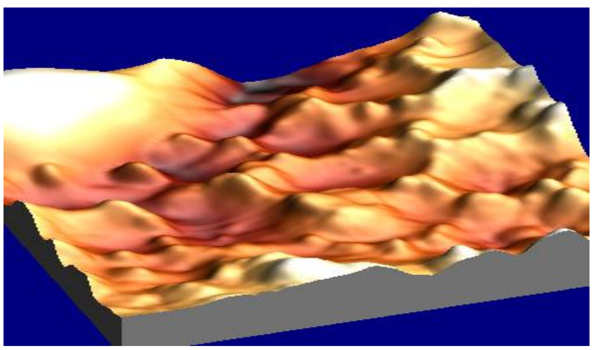

Figure 7: Al_2O_3 Film etched in nitrogen plasma for 30mins.

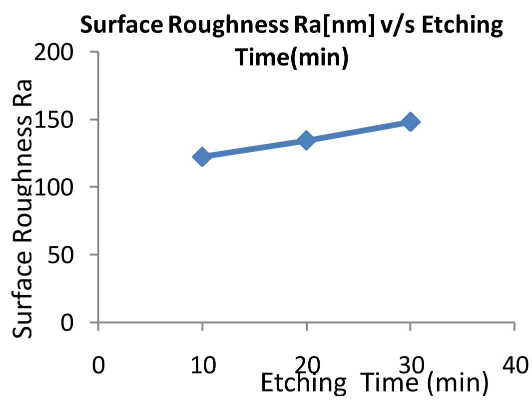

Figure 8: Shows the change in Surface Roughness of Al_2O_3 Film etched in nitrogen plasma.

EFFECT OF OXYGEN PLASMA ON Al_20_3 FILM: SAMPLE A3

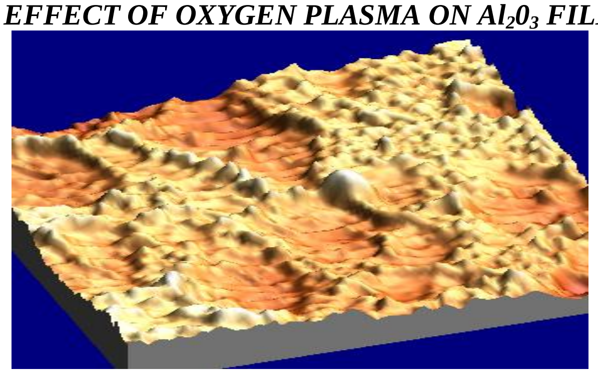

Figure 9: Al_2O_3 Film etched in oxygen plasma for 10 mins.

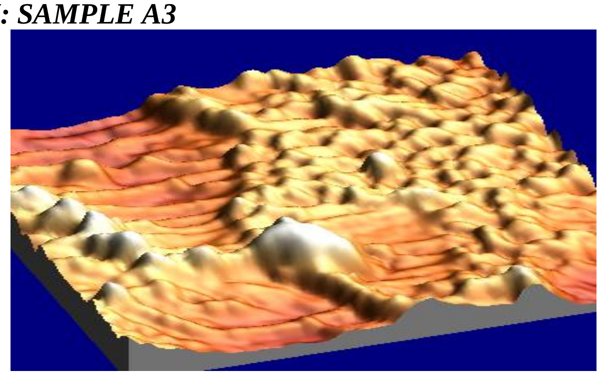

Figure 10: Al_2O_3 Film etched in oxygen plasma for 20 mins.

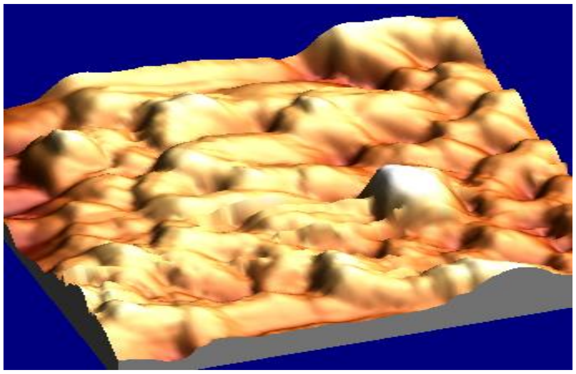

Figure 11: Al_2O_3 Film etched in oxygen plasma for 30 mins.

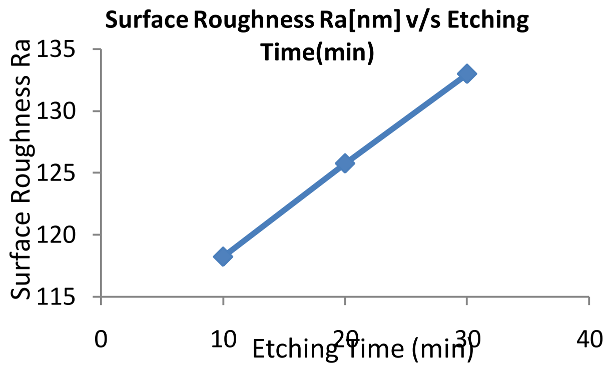

Figure 12: Shows the change in Surface Roughness of Al_2O_3 Film etched in oxygen plasma at three different intervals of time.

Conclusion

Film thickness increases when the anodizing current density and time are raised. The results show that the experimental conditions (anodizing time and current density) are crucial for the final state of the fabricated coatings and especially for the aluminium substrate surface preparation. Plasma etching was used for removing surface contamination and passivation. The most notable difference between images is the change in roughness. The plasma etches had a leveling effect on the surface.

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