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In-situ FT-IR monitoring of a MOCVD process for the growth of Al film using aluminum boro-hydride trimethylamine

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Until now, aluminum has been widely used as a conducting material in the fabrication of integrated circuit (IC) and new precursors for aluminum are still being synthesized. In this work, the nucleation and growth of MOCVD aluminum and its bulk properties from a recently developed precursor, aluminum boro-hydride trimethylamine (ABHTMA), has been studied. Thin and conformal aluminum film was successfully deposited by MOCVD on 100 nm-thick as sputtered TiN coated on the Si wafer in the temperature range of 100°C-250°C. Argon was used as a carrying / dilution gas and their ratio was purposely varied to see the effect on the film property. To prevent the pre-decomposition of precursor, the temperature of a shower head was strictly controlled at 40°C. The SEM was used to measure the film thickness and observe the microstructure. XRD was introduced to determine the preferred orientation of the film, which is important for electromigration resistance. In addition, XPS and AES was used to investigate the film purity that is one of the decision factors for resistivity. And AFM was utilized to measure the film roughness.

When the substrate temperature was 150°C, the film showed the highest quality in terms of high <111> preferred orientation, low resistivity and high purity. In that condition, the exhaust gas was extracted from the line connecting chamber to pumping system and introduced to the FT-IR spectrometer with the gas cell. For the precise measurement, the sufficient pressure , about 300 mTorr , was maintained inside of the cell. IR absorption spectra were acquired when the substrate temperature was in the range of 40°C-250°C and recorded every 3 minutes. The correlation between in-situ infrared absorption spectra and the property of film was characterized. This noncontact, nondestructive in-situ monitoring represents a useful and viable tool for understanding the deposition mechanism and reaction pathway in the aluminum CVD from ABHTMA precursor.