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Chemical and Electrical Properties of Polyimide Thin Flim Fabricated by Ionized Cluster Beam

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1. Introuction

Ionized cluster beam deposition(ICBD) technique is known to be an unique film formation technique that enables the flexible control of film properties such as molecular orientation, film crystallinity, chemical purity, and film-substrate interface. Thus we employed the ICBD technique to fabricate highly purified PI films. We investigate the surface chemical properties, the interfacial properties, and the electrical conduction mechanism in the PI films deposited by ICB. From C-V characteristics, the PI film deposited with ICB is found to have fairly low interface trap density. The conduction mechanism in ion implanted PI film is described in terms of the conducting grain model.

2. Experimental procedures

Two ICB sources(PMDA and ODA powder) were used to deposit PI films, and the surface chemical properties were studied with X-ray photoelectron spectroscopy(XPS). The film-substrate interface properties were studied by measuring high frequency (1 MHz) capacitance-voltage (C-V) characteristics of Au/PI/Si metal - insulator-semiconductor(MIS) device. In order to elucidate the electrical conduction mechanism, mass-analysed low energy ($\leq$ 5 keV) Li^+, Na^+, and K^+ ions were implanted into the PI films deposited by ICB, and electrical conductivity of the ion implanted PI films was measured by using an automatic 4-point probe. We examined the temperature dependence of the electrical

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conductivity to investigate the conduction mechanism of the ion implanted PI films deposited with ICB.

3 .Results and discussion

The chemical and electrical properties of PI film deposited by ICBD have investigated in this study. This technique is found to be capable of growing PI film having good chemical and electrical properties. The parameters of the ICBD system play an important role in determining the chemical and electrical properties of PI film; the optimization of deposition parameters is found to improve the imidization, purity and interfacial properties presumably due to the high surface migration energy, surface cleaning effect and creation of activated centers for nuclear formation induced by ICBD. The conduction mechanism in ion implanted PI films is supposed to be due to the conducting grain model, which is directly related with the size of conducting grain induced by ion irradiation.

4. Conclusions

We conclude that this ICB technique is very effective for the polymerization using physical method and has wider range of application to organic materials because of the flexibility in controlling the deposition.

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