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Preparation, Morphology and Properties of Nano-Sized Al_2O_3/Polyimide Hybrid Films

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In recent years, polyimide hybrid materials have received considerable attention due to the dramatic improvements over their pristine state in thermal stabilities, mechanical properties and other special features by introducing only small fraction inorganic additives.

In the present study, the Al_2O_3/polyimide hybrid films were investigated, aiming at improvement the electrical insulating properties of polyimide films to prolong the life of the film in a voltage stressed environment. Nano-sized Al_2O_3/polyimide (PI) hybrid films based on 4,4'-oxydianiline (ODA) and pyromellitic dianhydride (PMDA) were prepared by incorporation with different content of nano-sized Al_2O_3 via in situ polymerization. The TEM and SEM micrographs indicated that the Al_2O_3 particles were homogenously dispersed in the polyimide matrix by means of the ultrasonic treatment and the addition of coupling agent. The mechanical properties and thermal stability of the pure PI film can be improved by adequate addition of Al_2O_3. The PI hybrid film was strengthened and toughened simultaneously by the introduction of the well-dispersed Al_2O_3 particles. The PI hybrid films showed improved electrical aging performance as compared with pure PI film. Especially, the PI hybrid films with 10 wt.% of Al_2O_3 content exhibited obviously enhanced electrical aging performance with the time to failure of 3.4 times longer than that of pure PI film. The morphology and the surface composition of PI hybrid films before and after electrical aging were investigated by SEM observation and XPS analysis. It is suggested that improved electrical aging performance of the hybrid film was attributed to the highly dispersion of nano-sized Al_2O_3 particles in PI matrix, which cause the diffusion of partial discharge and dissipation of local dielectric heating as a constant voltage applied on the hybrid film.

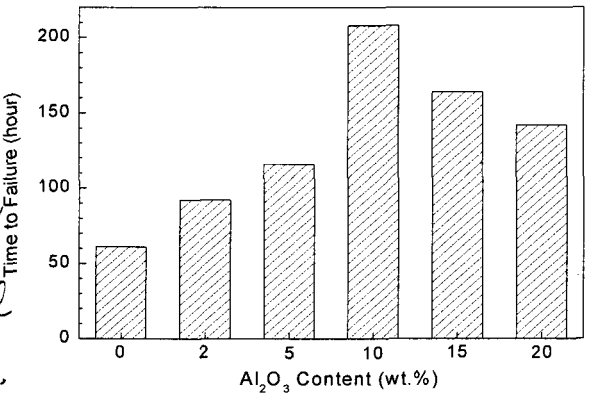

Figure 1. Time to failure of Al_2O_3/PI hybrid films in electrical aging at 1 kV.

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