In Situ Formation, Characteristics, and Interfacial Adhesion of Polyimide/Titania Nano Hybrid Films

Student: Pei-Chun Chiang Advisor: Dr. Wha-Tzong Whang

Department of Materials Science and Engineering

National Chiao Tung University

ABSTRACT

A new polyimide/titania (PI/TiO_2) nano hybrid film has been successfully fabricated through the in situ formation of TiO_2 within a polyimide matrix by sol-gel process. By using catalyst-free polymerization, acetylacetone (acac) is employed to reduce the hydrolysis rate of titanium alkoxide through the formation of an acetylacetate complex.

The nano hybrid films of TiO_2 in polyimide from 2,5-bis(4-amino-phenyl)1,3,4-oxadiazole (BAO) and 4,4′-oxydiphthalic anhydride (ODPA) are synthesized and characterized with regard to the chemical states, average sizes, and spatial distribution of TiO_2 particles. The TiO_2 content in the hybrid films can be as high as 40 wt%. Moreover, the thermal and optical properties of the hybrid films are compared with those of host polyimide.

Another three series of PI/TiO_2 hybrid films are synthesized to facilitate the study of several structure/property responses, including the thermal expansion, mechanical properties, viscoelastic transitions, and electrical properties. These hybrid films are based on 4,4'-diaminodiphenylether (ODA) and various dianhydrides and incorporated with TiO_2 content from 1 wt% to 9 wt%. The effect of TiO_2 content on the aforementioned properties is also investigated.

The work presented herein also attempts to investigate the adhesion strength between the PI/TiO_2 hybrid films and copper system. The influence of TiO_2 content on the surface roughness, surface energy as well as adhesion strength is studied. To improve the adhesion strength, modification of plasma treatment (Ar, Ar/N_2, and Ar/O_2) is also applied to the hybrid films. The changes in surface morphology, surface energy, chemical composition, and peeled-off failure mode as a result of plasma etching are observed. Finally, based on the results of this research, recommendations are made for the future work.