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In-plane Thermal Conductivity and Adhesion Strength of Graphene based Pressure Sensitive Adhesives

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Extended Abstract

As electronic systems become small, the thermal management becomes more crucial to the overall system performance. The performance and reliability of the electronic devices and components is closely related to the thermal management. Thermal conductive pressure sensitive adhesives (PSAs) have been widely used in display applications. It is essential to understand the principles of the thermal conductivity of adhesives.

Thermal conductive PSAs are usually acrylate or silicone based formulations containing the thermal conductive fillers. They offer a superior thermal conductivity and effectively transport the generated heat to outside of the systems. The PSAs possess the advantage of the secure mechanical bonding and thus become one of the most potential options for thermal dissipation.

In this study, the matrix of PSAs was made from acrylic oligomer, 2-ethylhexyl acrylate (EHA), Isobornylacrylate, N-vinylpyrrolidone, and trimethylolpropane triacrylate. The photoinitiator was 2-hydroxy-2-merhyl-1-phenyl-propan-1-one. All the ingredients of acrylic resin were mixed and UV cured. Graphene (G), a novel material, has a high thermal conductivity, high carrier mobility and high optical transmittance, has become a promising candidate for heat dissipating applications. The effective thermal conductive path of filler is a key parameter to the thermal conductivity of adhesives. In order to obtain a connected thermal path between fillers in the matrix, graphene was chosed as a conductive filler and it was added up to 20 wt.%. A series of graphene based thermal conductive PSAs were prepared and the thermal conductivities in the in-plane and through plane directions were measured. The filler ratio and acrylic monomer compositions were changed as experimental parameters. The thermal diffusivity of PSAs was measured using laser flash method and heat guarded method.

The through-plane thermal conductivities of graphene based PASs increased up to 0.5 W/mK, while that of the in-plane conductivity showed a considerable increase up to 2.0 W/mK compared to that of neat acrylic resin. The increase in the in-plane conductivity was almost linear with the increase volume of graphene up to 20%. An obvious anisotropy with respect to the thermal conductivities was observed for the high content of graphene. This should be attributed to the orientation of grapheme in acrylic matrix. The fillers with the high aspect ratio often align along the in-plane direction at higher loadings. The PSAs comprises of only graphene fillers, the in-plane conductivity is about three times higher in order than the through plane. The adhesive strength was measured using 90^{o} peel test. The adhesion strength was ~1500 kg_f/25 mm at graphene content of 10 wt%.

In addition, the thermal conductivity and peel strength of graphene contained adhesives was compared with graphene/BN hybrid acrylic adhesives.