MECHANICAL AND CONDUCTIVIE PROPERTIES OF SILICONE FILLED GRAPHENE ELECTRICALLY CONDUCTIVE ADHESIVE (ECA)

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ABSTRACT

MECHANICAL AND CONDUCTIVIE PROPERTIES OF SILICONE FILLED GRAPHENE ELECTRICALLY CONDUCTIVE ADHESIVE (ECA)

The aim is to synthesize a silicone-based graphene electrically conductive adhesive (ECA). Silicone ECA incorporated with graphene as filler, may exhibit mechanical and electrical properties different than other types of ECA. Hence, the objective of the study is to investigate the mechanical and conductive properties of various graphene loading (0%, 3%, 5%, 7%, and 9%) filled silicone. Addition of polyethylene glycol (PEG-600) to graphene for mechanical properties improvement with different loading percentage was done using ultrasonication and magnetic stirring. The curing process was done by oven heating at 100°C for 4 hours. Characterization was done using tensile test and FTIR, while for the electrical properties were done using electrochemical impedance spectroscopy (EIS) and Tafel plot. For EIS, Nyquist plot was used to determine the conductivity of the samples with result of optimum value at 9% (4.87×10^{-06} S/cm). It was found that the conductivity is dependent on the graphene loading percentage due to its inherent electrical conductivity properties which then resulted in high polarization resistance (10.9690×10^{9} Ω at 9% GNP) when tested using Tafel plot. The electron in graphene has a long mean free route, producing a continuous channel that facilitates free electron movement for electrical conduction without interfering with electron-electron interaction or disorder. As a result of the electrolyte's susceptibility to be drawn to the composite and oxidised, the adhesive has a longer shelf life. With an optimum value obtained was at 7%, the tensile strength obtained was 0.305 MPa and the Young’s modulus was 146.523 MPa, before the value decreases as graphene loading increased due to the inherent properties of graphene that have a strong covalent bond between its carbon atoms. When the material's surface contact rises, the chain mobility of silicone-filled GNP decreases, which can also improve the composite's stiffness. The FTIR testing was done to confirm the presence and dispersion of graphene in the silicone and PEG-600. The emergence of -OH, CH, C=C, and C=O functional groups proves that the graphene was successfully introduced into the polymer with the -OH peak migrated to a higher strength at optimum value.

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CHAPTER 1

INTRODUCTION

1.1 Background study

Industries concerning electronic packaging have long used the soldering process of metal solders especially lead-based solders to interconnect electronic components by enabling electron pathways for connection. This method uses a high temperature, about 150 ℃ along with high current and voltage usage (Chen, 2019). Due to it using metal such as lead and tin for its low melting point, customary solders are currently considered to be unacceptable for applications that need high spatial resolution and exceptionally risky to the climate and human health. Soldering with lead can produce dust and fumes which are hazardous and can cause respiratory problem when it is inhaled. For environmental effect, lead can cause water and soil pollution which later will affect organisms. Exposure to elevated level of lead can lead to anaemia, kidney and brain damage as well as disrupting reproductive and development systems. These are some of the many reasons why conventional Pb-Sn solders have long been replaced by ECA.