Understanding the interaction between automotive silver tracks and lead-free solders

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Abstract

Since 2016, EU legislation require all new car models must use lead-free soldering technology for soldering connectors on glass. Understanding the underlying mechanisms of soldering T-piece connectors to Conductive Silver tracks is a critical step in developing suitable automotive silver pastes for heated windscreens. The fired Conductive track is composed of glass frit and silver and the solder is required to endure temperature variations , have high electrical conductivity and good corrosion resistance.

Historically Lead based solders were used for this application due to being cheap , having good surface wetting properties and low melting point . However , these properties do not out way the fact that lead is inherently toxic which meant its use was prohibited by EU in electronics.

Based on the Sn-Ag-Cu system, the near ternary eutectic composition of 96.5Sn-3Ag-0.5Cu (SAC 305) is one of the most promising composition for automotive solders. In comparison to the homogenous lead-tin system , SAC 305's tendency to form intermetallic compounds has been detrimental to the strength of the joints. The dominant reaction product at the interface is the formation of the brittle intermetallic Ag3Sn, between solder and the silver particulates in the conductive track . The formation of Ag3Sn in the interface between conductive paste and solder facilitates crack initiation and propagation leading to a significant weakness of the joint in comparison to Lead-based solders .

Tin based solders have lower ductility than lead-based solder materials, often too brittle and cannot fully compensate the mechanical stresses of the soldering process. This is further amplified during the industry standard weathering and climate tests, which the joints need to undergo as part of quality control, leading to tin-based soldering joints failing and also in real-world conditions during the warranty period.

Although research has been carried out to understand the welding of SAC305, this research has been based on optimisation for semi-conductor manufacture . Even then , most of the research has been in the joining of SAC305 to a Copper Substrate . Although there are some similarities between the reaction mechanisms between SAC305 and Copper to that of SAC305 and Silver the results are not directly transferable .

Through systematic investigation , this project aims to investigate the fundamental reactions at the interface between Lead-Free solders and Silver based conductive tracks for the development of enhanced joints for Automotive manufacture .

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