The Reliability of the Electrically Conductive Adhesive Joints on Non-Noble Surface Finishes under Ageing in Different Environments

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The electrically conductive adhesives (ECAs) provide a large number of opportunities for the electronic manufacturing. They are environmentally friendly and have much lower processing temperatures, so the heat impact on the electronic components can be reduced, comparing to soldering or sintering. It makes them suitable for interconnecting the temperature sensitive elements in the packages, for example in liquid-crystal displays or modules of flexible thin film solar cells. However, this type of interconnections has to overcome some challenges. As the contact to noble metals (Pt, Au, Ag) has relatively low electrical resistance and is stable to the environment loads, in the ECA joints to non-noble metals the degradation happens (increase of contact resistance, decrease of adhesion) [1]. That's why it is important to investigate such type of joints for stability under different ageing conditions.

Most of the latest investigations in this field are concentrated on the ECA joints to Sn and its alloys, because this non-noble metal is widely used in the electronic packaging. This system of contacted materials remains stable under the (120 °C) thermal ageing [2], but suffer from increase of the contact resistance after heat/humidity ageing (85 °C/85% RH) and accelerated thermal cycling (-40 to 125 °C) [1-3].

Another contact of non-noble metal to ECA that needs to be investigated is Mo to ECA. Molybdenum is used as a back contact in thin film solar cell manufacturing ($CuIn_{1-x}Ga_xSe_2$, or CIGS, solar cells) and the ECAs are used for interconnection and assembling the individual cells in modules [4]. This approach is especially important for the thin film solar cells on flexible (polyimide) substrates, because polyimide cannot withstand temperatures more than 450 °C. The focus of the recent investigations is to examine the contact behavior between ECAs and non-noble, molybdenum films under different aging conditions. The experiments are focused on the electrical conductivity. The goal of the work is to investigate the degradation behavior of non-noble metal - ECA joints and to predict the reliability of this type of an electrical contact.

The samples were prepared on two different substrates: soda-lime glass (SLG) and polyimide (PI), in order to reproduce the structure of the thin film solar cells on rigid (SLG) and flexible (PI) substrates. The Mo layer (800 nm thick) was deposited onto the substrates by sputtering through the metal mask, so the structure of 25 metal pads (6 x 6 mm^2) with 3 mm pitch were obtained. The adhesives were printed with a metal stencil with a nominal thickness of 50 µm (Fig. 1). For assuring statistical significance the test board has 20 equal depots applied with 1 printing step. Three types of ECAs were used, all filled with Ag flakes. The aging conditions were thermal storage by 60 °C and 120 °C, heat and humidity ageing by 85 °C/85% RH. The resistance was measured periodically during the ageing with a 4-point method. The cross-sectional analysis on the interface molybdenum - ECA using scanning electron microscopy is also performed (Fig. 2).

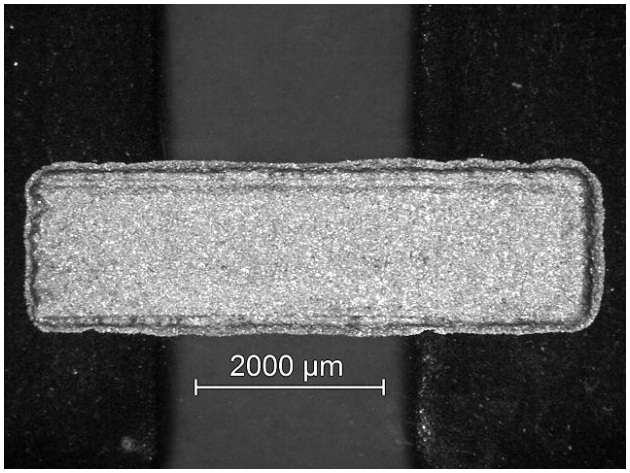

Fig. 1: ECA applied between metal (Mo) pads for the electrical measurements.

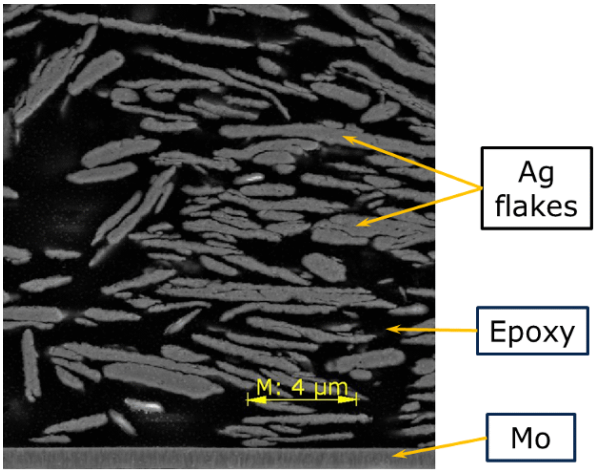

Fig. 2: Cross-sectional SEM image of the Mo/ECA joint.

References

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