Au-Sn powders production by cementation from solutions

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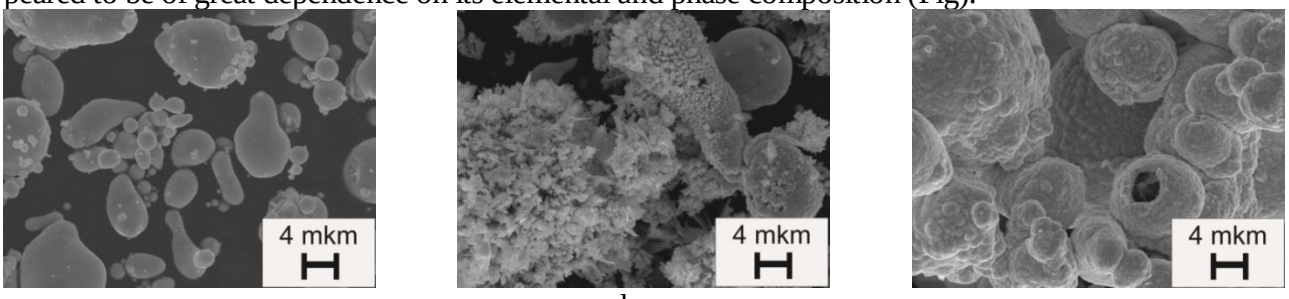
Au–Sn eutectic alloy is one of the most used soldering materials for packaging. It is indispensable for integrated circuits, laser diodes and other devices because it provides hermetic sealing owing to good surface wettability of the surfaces under connection, low viscosity at melting point and filling the cracks in a substrate [1]. Nowadays, Au−Sn alloy powders production is of great interest for usage in solder pastes. Traditionally, gold-tin powders are produced by sputtering of metallurgical alloy in vacuum. This technology is energy-consuming and requires expensive equipment that is why the search of new methods of powder production is of great importance. Cementation processes based on the reduction of metal ions by a metal with more positive electrode potential proceed in aqueous solutions on metal surfaces of complex shape. They provide to produce metal coatings and powders by a cheap and simple way without complicated installation [2]. Moreover, it is known that intermetallic compounds are formed sometimes during the cementation process [3], but there is no information about gold(I) reduction with tin.

In this work the process of gold cementation on Sn powders with formation of Au−Sn alloys was studied. Commercial tin powder was used as a substrate. Gold cementation was carried out at 90 ± 2 °C in solutions containing potassium dicyanoaurate(I), citric ions as a ligand, and ammonium chloride as a buffering additive providing an initial pH 7.

The research revealed that Au(I) was reduced from solution by tin with the formation of Au−Sn alloy. That fact was confirmed by the change of tin powder color, by the results of EDX and X-ray phase analysis. The elemental and phase composition of the alloy powders depended on the duration of the process and molar ratio of Au(I) : Sn. The latter was determined by the weight of tin powder introduced into Au(I) cementation solution and the volume of this solution. Thus, the excess of tin powder resulted in the formation of $AuSn_4$ intermetallic compound. At molar ratio Au(I) : Sn equal to 1 : 5 and 1 : 2 phases of $AuSn_2$ and AuSn were obtained respectively. The optimal molar ratio for the formation of the eutectic alloy (Au_5Sn, AuSn; 70 at.% Au and 30 at.% Sn) was 1 : 1. The excess of Au(I) led to the formation of a product with high (83 at.%) content of gold included into phases of AuSn intermetallic compound and amorphous gold. The morphology of Sn grains sufficiently changed during Au(I) reduction. The size and form of the particles in the cementation product appeared to be of great dependence on its elemental and phase composition (Fig).



a b c

Fig. SEM photos of the surface of Sn (*a*) and Au–Sn (*b*, *c*) powders of different composition: *b* – $AuSn_2$ phase, 25 at. % Au; *c* – AuSn and Au_5Sn phases, 75 at. % Au

Thus, the obtained results show the possibility to produce Au−Sn alloy powders by Au(I) cementation from solution and to control the elemental and phase composition of the alloy.

References

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