Solderability of ceramic materials

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The issue of solderability of ceramic materials consists mainly in the fact, that the ceramic materials are non-wettable for commercial solders, owing to their ionic and covalent bond amongst the atoms. There exist several ways to ensure wettability of ceramic material surface. One of them for example consists in coating of ceramic material with a metallic layer. More perspective way seems to be application of soldering alloys which are alloyed by small amount of elements providing high affinity to some component(s) of ceramic material. The main group are the so-called active solders which contain from 1 to 5 weight % Ti, eventually another active element as Zr and/or Hf [1]. The solders alloyed by a small amount of lanthanoids are another group of solders that can wet the ceramic material. Content of lanthanoids usually varies from 0.1 up to 2 wt. % [2]. The last group consists of solders containing indium in amount from 20 to 100 wt. % [3]. The aim of work was to select a suitable solder from each group, to analyse the interactions between the solder and ceramic substrate and to determine the strength of fabricated soldered joints. To improve the wettability, soldering in combination with an active power ultrasound was employed. Experiments were performed with Al2O3 ceramics. For comparison, also reference Cu substrate material with 4N purity was used. The soldering alloy type Sn2Ti, Sn3.5Ag4Ti(Ce, Ga), Sn2La and Bi25In18Sn were used. EDX analysis was applied for the study of interactions on the boundary of soldered joints. Different mechanisms of joint formation were revealed. In case of solders containing 2 to 4 wt. % Ti it was found out that the active element in solder reacts with the surface of ceramic material in soldering process at formation of a reaction layer. The reaction layer allows wetting of ceramic material. The bond is of diffusion character. In case of In containing solders, the dominant role in joint formation is played by indium. Indium exerts a high affinity to oxygen and it is therefore supposed that it is combined with oxygen from the air in soldering process at formation of complex indium oxides which subsequently enter into reaction with the surface oxides of ceramic material. The bond is of quasi-adhesive character. Considerably higher shear strength was achieved with Ti containing solders. This was caused on one hand by higher strength of diffusion bond with the surface of ceramic substrate and, on the other hand by higher cohesion strength of soldering alloy proper.

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