Development of a Method to Measure Contact Angles of Sessile Droplets to Analyze and Enhance the Surface Wettability of Nichrome

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Nichrome (Ni/Cr) alloys are used in many industrial applications due to their better electrical properties and commercial availability. It is a known fact that these alloys are having a surface passivation layer of chromium oxide (Cr_2O_3). This oxide passivation layer changes the surface tension of the metal surface, therefore, decreases the surface wettability during soldering. This phenomenon is critically addressed in electronic applications because the wettability inhabitancy of nichrome thin films tends to reduce the solderability of the metal. The decrease in solderability will lead to many difficulties such as poor connecting strength of wires and fluctuations of resistance. In this study, two approaches were introduced to enhance the wettability of nichrome alloy surface.

In the first approach a liquid salt solution was used in an acidic environment ($ZnCl_2$/HCl) to remove the oxide passivation layer, thereby, to enhance the wettability of the nichrome alloy. Lead-free industrial solder alloy, SN100C (Sn / Cu 0.70% / Ni 0.06% / Ge 0.005%.) was used as the soldering material for this experiment. Solder drops were formed on the Nichrome thin film (With and without treatment of ($ZnCl_2$/HCl) in 325-350°C temperature range. The second approach was an electroplating process to form a thin nickel coat (3 µm) on the nichrome surface. A two-step plating process was carried out. Various plating conditions such as pH-condition, thickness and current density were controlled of the watts bath to obtain the best wettability and adhesion.

An experimental setup together with an image processing software was developed to process the image of the solder droplet and measure the contact angles of the nichrome-solder alloy interface. The contact angle measurements were based on the sessile droplet method. The polynomial and ellipse fitting methods were used to digitize the drop shape.The results of the study show that the contact angles of solder droplets were reduced by more than 50 percent after the $ZnCl_2$/HCl treatment. Contact angles can be reduced by more than 60 percent by nickel electroplating. Therefore, the solderability of the nichrome alloy is significantly enhanced by both treatments.

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