CANADIAN WELDING ASSOCIATION

INVESTIGATING
the copper-chromium electrodes deformation during the welding process of resistance spot welding

Joining the carbon and stainless steels in spot welding process is widely recommended by using class two alloys from Resistance Welder Manufacturers Association (RMWA) [1]. The ground for this sort of recommendations is that it has superior resistance, heat toleration and high corrosive opponent in itself [2].Without the mixture of substances, a pure copper is intrinsically soft and fails prematurely in demanding applications [3]. Mixture of substances is, therefore, a good choice for the manufacturing of electrode caps as to produce superior qualities, specifically for the mechanical and electrical properties. With this consideration in mind, copper-chromium based electrode caps are practically tested to weld approximately nine hundred weld pairs of carbon and stainless steels sheets in this experimental work. *Figure 1* shows the copper and chromium phase diagram for copper based alloys [4]. It shows that the chromium is easily soluble in the Liquids of copper when heated above 1076 ºC and below 1860 ºC. Once the compound is solidified, it requires an equal amount of heat to re-melt it again [5]. This factor creates significance in the welding of the carbon and stainless steels because the carbon steel melting point falls between 1426 to 1540 ºC and the stainless steel melting point falls between 1400 to 1450 ºC. The copper and chromium solubility phases are actually of the eutectic type. The face centered cubic (FCC) will be formed in copper while body centered cubic (BCC) will be formed in chromium when solidification process is concerned in copper-chromium alloy.

Fundamentally the welding process is varied by its process parameters which consist of the welding current, weld time, electrode tips' diameters and electrode force [6]. These parameter variations establish the corresponding heat growth for any materials for which the bonding strengths are mainly anticipated. By doing so, the amount of heat that is produced in an enclosed area of electrode tips will cause the electrode tips' deteriorations. Another factor that obviously affects the electrode tips deteriorations is the electrode pressing forces which is primarily supplied by the pneumatic pressure in this research. Thus, every time the electrodes are pressed to hold the weldable materials together, the hitting effects of electrode tips towards the base metal results in metal hitting effects or simply the hitting effects, subjected to its fatigue. In this experiment the mushroom growth, degradation as well as the deterioration is what is examined for the copper-chromium electrode caps using a 75 kVA spot welder. Part of this research has been previously published for the simulation, tensile shear strength, hardness distribution and the metallurgical analysis and therefore, such information is excluded in this paper but relevant references are given by [7].

2. EXPERIMENTAL

The base metals were prepared in rectangular shape with a size of the length (200 mm), width (25 mm) and thickness (2 mm). The chemical elements found on stainless steel sheets were: C = 0.046, Cr = 18.14, Ni = 8.13, Mn = 1.205, Si = 0.506, S = 0.004, N = 0.051 and P = 0.030. The chemical elements found on carbon steel sheets were: C = 0.23, Mn = 0.095, Si = 0.006, S = 0.050 and P = 0.040. Hardness of austenitic stainless steels was 86.2 HRB whereas as for the carbon steel, it was about 65HRB. A pair of water cooled (4 liters per minutes) truncated-cone electrodes, with 5 mm of round diameter was applied to join these base metals as shown in *figure 2*.

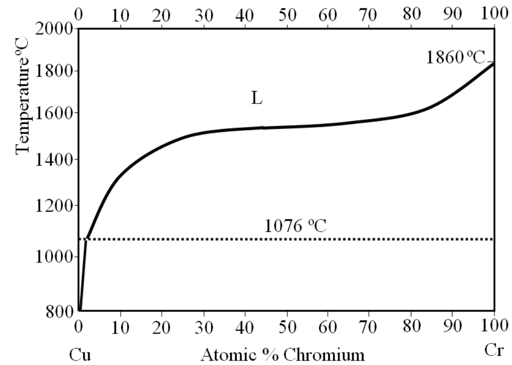

Figure 1: Copper and chromium phase diagram (Chakrabarti DJ, 1984)

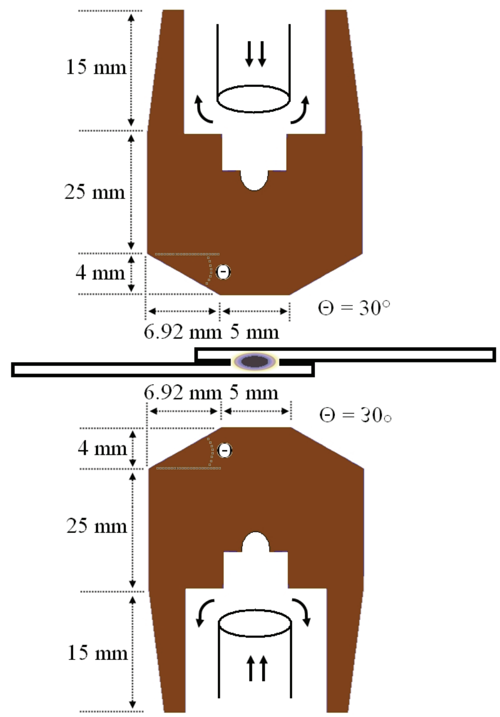

Figure 2: The dimension of electrodes on welding materials

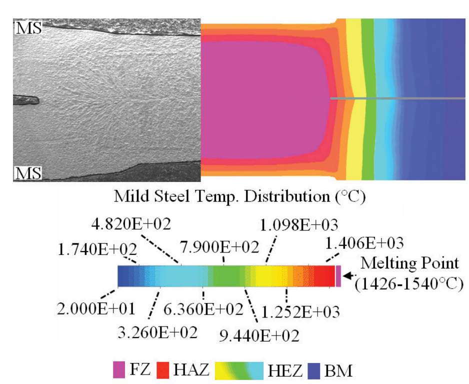

Figure 3: Carbon steel weld (real vs simulation)