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Modelling of Phase Transformation Kinetics in Post Heat-Treated Resistance Spot Weld of AISI 1010 Mild Steel

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Abstract : Automobile manufacturers are constantly seeking means to reduce the weight of car bodies. The usage of several steel grades in auto body assembling has been found to be a good technique to enlighten vehicles weight. This few years, the usage of dual phase (DP) steels, transformation induced plasticity (TRIP) steels and boron steels in some parts of the auto body have become a necessity because of their lightweight. However, these steels are martensitic, when they undergo a fast heat treatment, the resultant microstructure is essential, made of martensite. Resistance spot welding (RSW), one of the most used techniques in assembling auto bodies, becomes problematic in the case of these steels. RSW being indeed a process were steel is heated and cooled in a very short period of time, the resulting weld nugget is mostly fully martensitic, especially in the case of DP, TRIP and boron steels but that also holds for plain carbon steels as AISI 1010 grade which is extensively used in auto body inner parts. Martensite in its turn must be avoided as most as possible when welding steel because it is the principal source of brittleness and it weakens weld nugget. Thus, this work aims to find a mean to reduce martensite fraction in weld nugget when using RSW for assembling. The prediction of phase transformation kinetics during RSW has been done. That phase transformation kinetics prediction has been made possible through the modelling of the whole welding process, and a technique called post weld heat treatment (PWHT) have been applied in order to reduce martensite fraction in the weld nugget. Simulation has been performed for AISI 1010 grade, and results show that the application of PWHT leads to the formation of not only martensite but also ferrite, bainite and pearlite during the cooling of weld nugget. Welding experiments have been done in parallel and micrographic analyses show the presence of several phases in the weld nugget. Experimental weld geometry and phase proportions are in good agreement with simulation results, showing here the validity of the model.

Keywords : resistance spot welding, AISI 1010, modeling, post weld heat treatment, phase transformation, kinetics
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