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Effect of rotational speed on friction stir spot welding of AA5052-H32/HDPE/AA5052-H32 sandwich sheets

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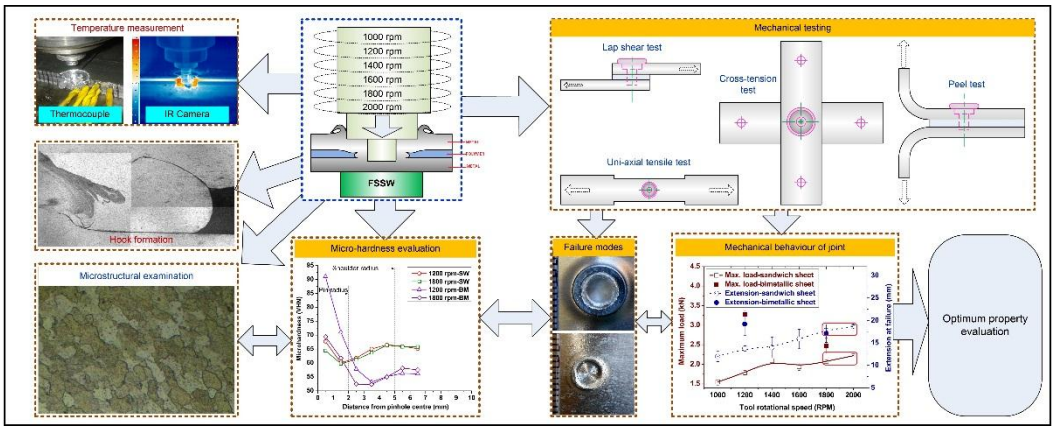
Graphical Abstract



Abstract

Friction Stir Spot Welding (FSSW) of AA5052-H32/HDPE/AA5052-H32 sandwich sheets is performed at six different tool rotational speeds to evaluate the optimum range. The mechanical performance, hook formation, grain size, hardness and temperature distribution are evaluated. Lap shear test, cross tension test, peel test and uni-axial tensile test are conducted. A comparative assessment has been made between the bimetallic and the sandwich sheets after FSSW. The optimum rotational speed for joining the sandwich sheet is 1800 rpm and beyond, where the joint strength and extension to failure are found to be acceptable. In hook formation, two hooks are prominently seen in the sandwich sheets, while it is only one hook in the bimetallic sheets. The hook width increases and the hook height decreases with increase in rotational speed. A mechanism has been proposed to explain such phenomenon. The peak temperature increases with increase in rotational speed and it gets reduced in sandwich sheet as compared to bimetallic. The polymer layer takes a part of the heat flux during stirring to reduce the peak temperature in sandwich system. The bimetallic joints are stronger than sandwich sheet joints showing better joint strength and extension at failure in almost all the tests. Joint hardness distribution supports such performance. Nugget pull-out and partial nugget failure are observed during joint failure of sandwich sheets.

Keywords: Sandwich sheets; polymer; friction stir spot welding; rotational speed; hook formation; failure modes