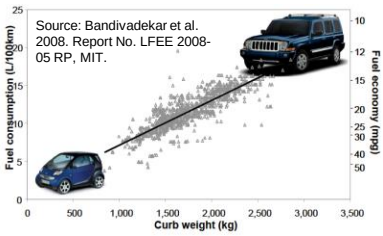
Joining of Al alloy and stainless steel thin sheets by thermally assisted plastic deformation

Chair for Hyper-functional Forming
Institute of Industrial Science, The University of Tokyo
Zhequn Huang and Jun Yanagimoto

Introduction and Background

Aluminum alloy/steel hybrid components are widely used in different industrial areas. However, further reducing component thickness for lightweight hybrid products has made the dissimilar joining of Al alloy and steel thin sheets (less than 1 mm in thickness) a greater challenge. In this research, an alternative dissimilar joining process by thermally assisted plastic deformation is proposed for thin metallic sheets. The effects of various parameters on the joining performance were investigated. After exposure to an elevated temperature of 450 ºC for 22 s, an optimized joint type was achieved by local plastic deformation using a simple punch-die pair. This joint type exhibited an average joint efficiency factor of 85.2% and average absorption energy of 1.69 kN·mm in tensile shear tests, as well as satisfactory joining performance in peel tests. Such high-quality dissimilar joints were realized by simply operated die forging in air, without any yielding gas, flux brazing or surface treatment.

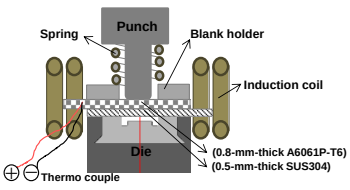


Fuel consumption is linearly proportional to the weight of transportation product.

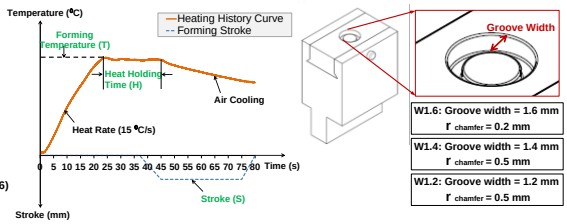
Combining lightweight and non-lightweight materials to develop lightweight hybrid structure is future trend.

Experiment Procedure

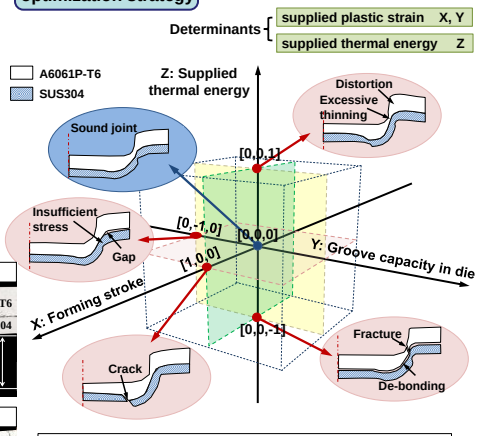
Compression machine assisted by induction heating



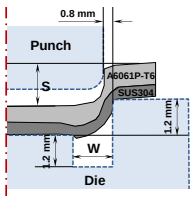
Experimental parameters and used die with groove

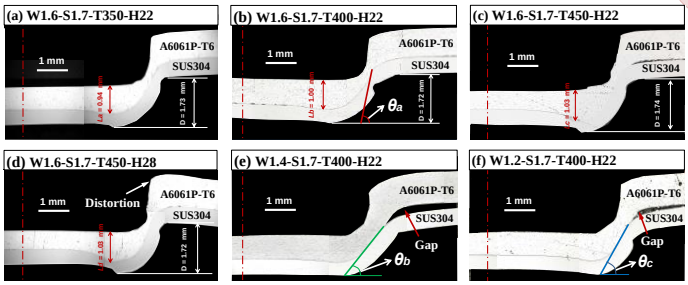


Parametric optimization strategy



Cross section

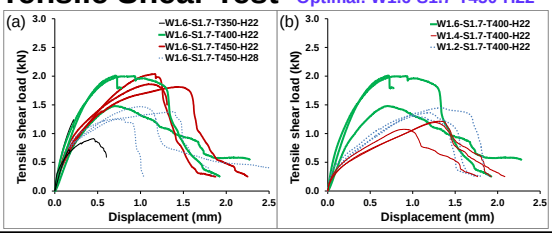




The W1.6-S1.7-T450 joint shows highest average ultimate tensile shear load in tensile shear test. The joint efficiency factor is 85.2%.

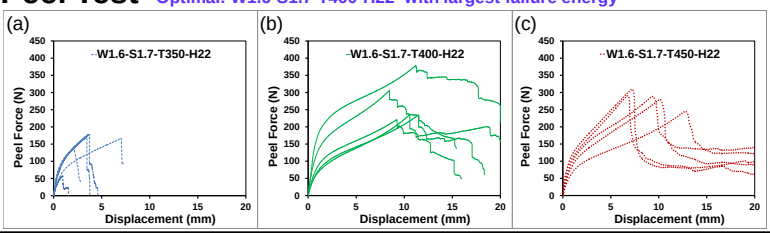
Tensile Shear Test

Optimal: W1.6-S1.7-T450-H22



Peel Test

Optimal: W1.6-S1.7-T400-H22 with largest failure energy



Joining Mechanisms:

Chemical bonding (800-nm-thick continuous interdiffusion layer at the interface, machoanchoring effect of the mechanical confinement and microanchoring effect.