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Microstructure and thermal history of explosive welded pure aluminum / SS400 steel joint

**Introduction**

Explosive welding

- A welding method for metal plates with high speed and incline collision.
- A solid-state welding.
- A useful method for dissimilar metal welding.
- A characteristic wavy interface and a few intermediate layer are formed.

**Problem**

It is important to examine the thermal history near the welding interface. But thermal history has not been revealed enough.

**Purpose**

The purpose of this research is to investigate the thermal history near the welding interface using both experimental and numerical analysis method.

**Numerical analysis results**

**Result of The SPH analysis**

- **Al**
  - Wavelength: 925 μm, Amplitude: 127 μm
- **SS400**
  - Wavy interface of the specimen: 500 μm
  - Wavelength: 685 μm, Amplitude: 127 μm
  - Thermal distribution of the wavy interface: 500 μm

**Result of The Open FOAM analysis**

- **Al**
  - Welded interface formation
  - Thermal distribution
- **SS400**
  - Welded interface formation
  - Thermal distribution

**Experimental method**

- Flyer plate: Al (A1100)
- Parent plate: Fe (SS400)
- Size: 300 × 300 × 6mm
- Impact velocity: 600 m/s
- Impact angle: 14.6°
- Observation: OM, SEM

**Experimental results**

**Result of the nanoindentation test near the welded interface**

- **Al**
  - Marks of nanoindentation test
  - Hardness distribution (GPa): 0 - 5

**Result of the nanoindentation test at the tip of wavy interface**

- **Al**
  - Observed area: 20 μm
  - Position of the nanoindentation test
  - Hardness distribution
  - Martensite: Hardness 7.36 GPa
  - Ferrite: Hardness 3.29 GPa
  - Intermediate layer: 2.84 GPa

**Conclusions**

- Microstructure change and thermal history of the explosive welded pure aluminum and SS400 steel joint were investigated by using both numerical and experimental analysis.
- The numerical analysis revealed that the region with martensitic structure in SS400 corresponded to the area in which the highest temperature and the highest cooling rate were observed except for the local melting area.