EVALUATION OF THE RESPONSE OF FRICTION STIR PROCESSED PANELS UNDER BALLISTIC LOADING

Authors: T. Johnson, B. Hinz, M. West, B. Jasthi, M. Ellingsen, C. Widener, and K. Muci

Introduction:

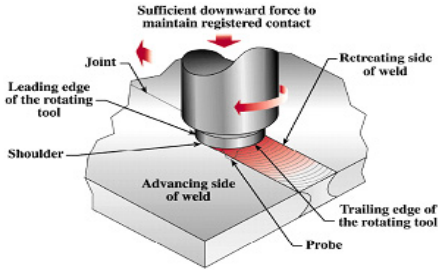
- Can Friction Stir Processing reduce spalling to minimize risk to vehicle occupants?
- Can panels be repaired using Friction Stir Processing?

Objective:

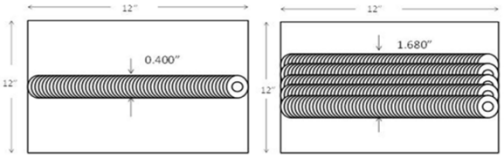
- Evaluate the response of Friction Stir Processed panels under ballistic loading.

Friction Stir Processing:

- FSP is an innovative microstructural modification technique, adopted from the principles of friction stir welding.
- A rotating pin tool is plunged into the material and the frictional heat generated between the pin tool and work piece softens the material without melting it. The plasticized material is moved from the front of the tool to the back and where it is consolidated. During this process the material undergoes re-crystallization, producing a refined grain structure.



Schematic of the FSW process(www.twi.co.uk).

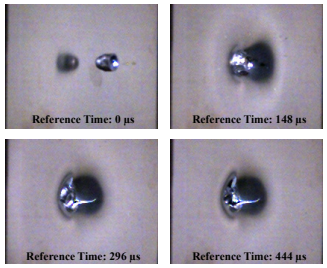


Schematic of a single-pass and multi-pass FSP.

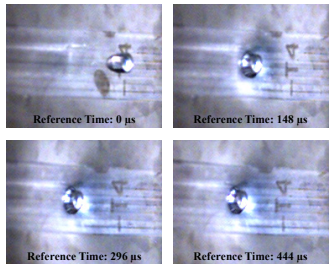
Approach:

- 0.080 in. (2.03 mm) 6019-T4 aluminum panels were FSP.
- FSP panels were subjected to impacts from 0.45-in caliber 170 grain (11 grams) projectiles at velocities up to 760 ft/s (232m/s).
- Measurements made during the tests and post-test metallurgical studies were used to evaluate and compare the performance of the processed and un-processed panels during high strain-rate loading.

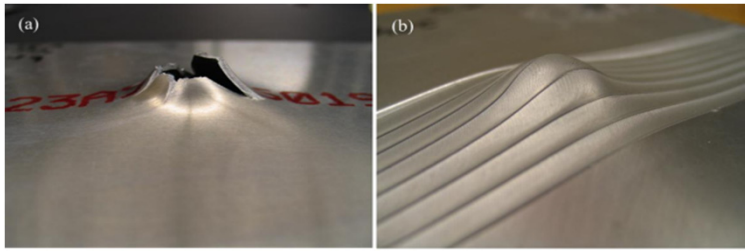
Results:



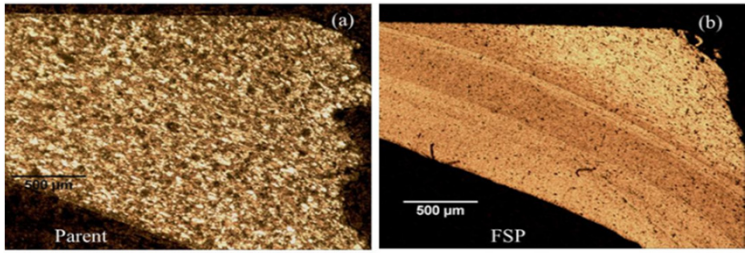
Parent material at impact.



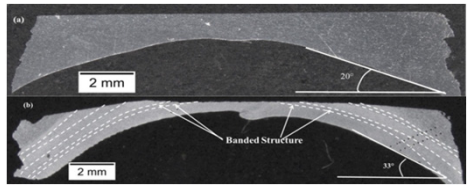
FSP material at impact.



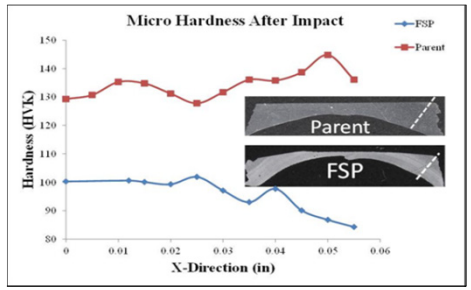
Panels after projectile impact (≈650ft/s); (a) parent material, (b) FSP material.



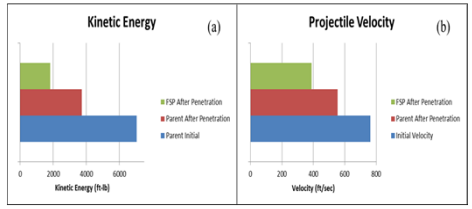
Deformation of the impacted region showing; (a) parent material, (b) FSP material.



(a) Parent material. (b) FSP material banded structure.



Microhardness after impact.



(a) Kinetic energy and(b) projectile velocity.

Conclusions:

- Friction Stir Processing improved the energy absorption over the parent material.
- Refined grains led to the formation of adiabatic shear bands during ballistic loading.

Future Efforts:

- Continue to examine the effect of high strain rate loading on friction stir processed material.
- Repeat the experiments with thicker panels.
- Attempt to repair impacted panels.

Acknowledgements:

- Kaiser Aluminum for providing the material.