



Manufacturing

Thermal Stir Welding

Solid State Welding Process

NASA's Marshall Space Flight Center is developing an improved joining technology called thermal stir welding that improves upon fusion welding and friction stir welding. This new technology enables a superior joining method by allowing manufacturers to join dissimilar materials and to weld at high rates. NASA's technology offers users an exciting alternative to state-of-the-art fusion and friction stir welding technologies.

BENEFITS

- Unique advantages of this technology over fusion welding or friction stir welding include the following:
- Totally independent heating and stirring functions
- More degrees of freedom for greater process control and optimization
- Easy assembly-line use
- Improved surface finish results
- High travel rates
- Separate heating function for easier welding of alloys with higher melting temperatures, such as steel and inconel alloys

technology solution



THE TECHNOLOGY

NASA's new thermal stir technology addresses shortcomings in fusion welding and friction stir welding. Fusion welding compromises the microstructure of the material and thus lessens its physical properties. Friction stir welding is limited by the dependent heating and stirring functions when using a rotating shoulder/pin configuration. The shoulder produces frictional heat to bring the material into the plastic state and forges the welded material with extremely large forces. This forging effect requires a very robust backing anvil for support. The welding pin, inside the workpiece, spins at the same rate as the shoulder, further restricting the process. This dependent motion of the welding pin and shoulder restricts the speed of the welding process.

The thermal stir process separates the characteristic heating and matrix transformation processes of the friction stir welding process. It can use a fusion welding apparatus (laser, plasma torch, etc.) to initially melt the material. It may also use a solid state heating process such as induction resistance heating. If a fusion heating apparatus is employed to heat the material, a separate grinding/extrusion feature recrystallizes the resulting dendritic matrix structure as it transforms from the melted temperature state through the plastic temperature state.

The heat sources that melt each material of the weld joint can be independently controlled. For example, a copper/aluminum weld joint can have independent temperature control as each alloy is brought into its respective plastic and melting states. This independent melting feature is advantageous because it provides a thermal environment conducive to the joining of dissimilar metals, such as copper and aluminum or stainless steel and titanium. Because these independent heat sources are kept separate from the weld matrix transformation feature (the grinding/extrusion teeth), higher weld travel rates are possible as compared to fusion and friction stir welding processes.

Unlike friction stir welding, this technology requires no backing anvil. The apparatus used for the weld process is enclosed in a main housing, which allows for the possibility of an inert environment in the melting compartment if needed.

APPLICATIONS

The technology has several potential applications:

- This technology has potential applications in the following industries, especially where fusion or friction stir welding is already used.
- Aerospace
- Automotive
- Shipbuilding
- Storage tank or cylinder manufacture
- Construction
- Railway cars

PUBLICATIONS

Patent No: 8,127,977; 7,980,449; 8,899,467; 8,225,984; 8,657,179

National Aeronautics and Space Administration

Sammy A. Nabors

Marshall Space Flight Center

Huntsville, AL 35812
256.544.5226
sammy.nabors@nasa.gov

<http://technology.nasa.gov/>

www.nasa.gov

NP-2014-08-1152-HQ

NASA's Technology Transfer Program pursues the widest possible applications of agency technology to benefit US citizens. Through partnerships and licensing agreements with industry, the program ensures that NASA's investments in pioneering research find secondary uses that benefit the economy, create jobs, and improve quality of life.

MFS-31559-1-CON, MFS-31559-1-DIV, MFS-32895-1, MFS-31559-2-DIV, MFS-32940-1, MFS-TOPS-7

