УНИВЕРЗИТЕТ У НОВОМ САДУ
UNIVERSITY OF NOVI SAD

TOP ACHIEVEMENTS 2021

FACULTY OF TECHNICAL SCIENCES

In-depth microscopic characterization of the weld faying interface revealing stress-induced metallurgical transformations during friction stir spot welding - Paper in the International Journal of Exceptional Values (M21a)

International Journal of Machine Tools and Manufacture, Vol. 164 (2021), https://doi.org/10.1016/j.ijmachtools.2021.103716

Danka Labus Zlatanović, Assistant Professor; Sebastian Baloš, Full Prof.; Jean Pierre Bergmann, Stefan Rasche, Janez Zavašnik, Vishal Panchal, Leposava Šidjanin, professor emeritus; and Saurav Goel authors from the Department of Manufacturing Engineering

In-depth microscopic characterisation of the weld faying interface revealing stress-induced metallurgical transformations during friction stir spot welding

Friction stir spot welding (FSSW) is a solid-state welding process, wherein the properties of a weld joint are influenced by the state of friction and localised thermodynamic conditions at the tool-workpiece interface. An issue well-known about FSSW joints is their lack of reliability since they abruptly delaminate at the weld-faying interface (WFI). This study explores the origins of the delamination of multiple lap welded aluminium alloy (AA 5754-H111) sheets joined by FSSW at different rotational speeds typically used in industry. Experimental techniques such as the small punch test (SPT), Vickers hardness test, Scanning Electron Microscopy (SEM), Scanning Acoustic Microscope (SAM), Transmission Electron Microscopy (TEM), Energy-dispersive X-ray spec-troscopy (EDX) and Frequency-Modulated Kelvin Probe Force Microscopy (FM-KPFM) were employed. The experimental results revealed that a complex interplay of stress-assisted metallurgical transformations at the intersection of WFI and the recrystallised stir zone (RSZ) can trigger dynamic precipitation leading to the formation of Al3Mg2 intermetallic phase, while metallic oxides and nanopits remain entrapped in the WFI. These metallurgical transformations surrounded by pits, precipitates and oxides induces process instability which in turn paves way for fast fracture to become responsible for delamination.