EXPERIMENTAL INVESTIGATION ON MECHANICAL AND WEAR CHARACTERSTACIS OF AZ91 HYBRID COMPOSITES PRODUCED THROUGH FRICTION STIR PROCESSING

Submitted by

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ABSTRACT

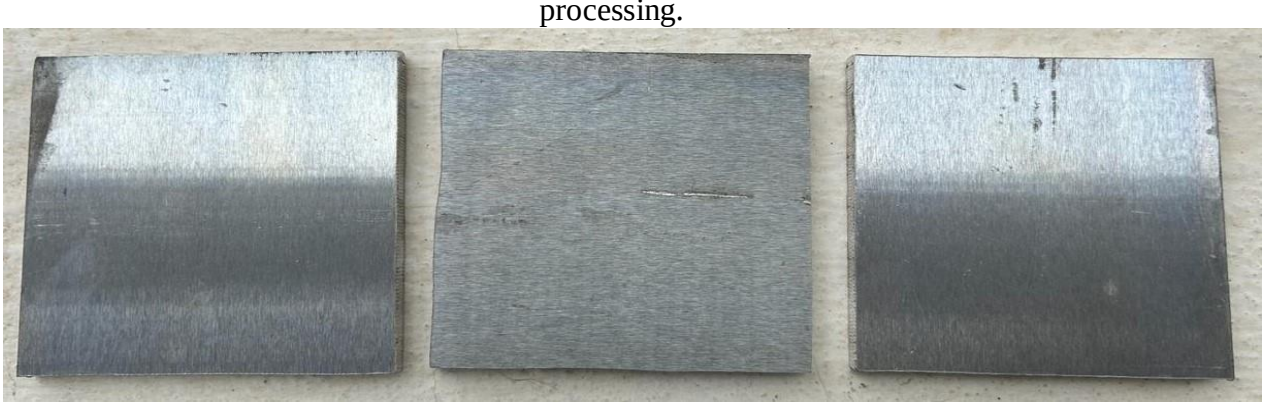
The study investigates the application of friction stir processing (FSP), an innovative method derived from friction stir welding, to enhance the properties of AZ91 magnesium alloy composites by incorporating Silicon Carbide (SiC), Aluminium Oxide (Al_2O_3), and Graphene (Gn) nanoparticles. Despite the widespread use of FSW and FSP in solid-state welding for magnesium and its alloys, a knowledge gap exists regarding the correlation between FSP parameters and the resulting material properties. This research addresses this gap by examining various FSP parameters, including tool rotational speeds (560, 900, 1400 rpm) and tool transverse speeds (25, 50, 63 mm/min), and their impact on the properties of Magnesium AZ91 alloy composites with SiC, Al_2O_3, and Gn nanoparticles. Magnesium alloys are highly favored in diverse industries due to their lightweight nature and exceptional strength. However, traditional processing methods encounter challenges when working with Mg alloys. FSP, on the other hand, offers remarkable efficiency in this regard. Microstructural analysis reveals that grain refinement increases with the addition of Gn nanoparticles. Mechanical tests, including tensile and hardness tests, were conducted on the AZ91 hybrid composite samples. Notably, composition consisting of SiC (66.6% vol.), Al2O3 (25% vol.), and Gn (8.33% vol.), processed at 1400 rpm and 63 mm/min, exhibited superior properties. Wear tests further demonstrated that this composition had somewhat lower wear rate compared to the base material, indicating reduction of almost 58%. Additionally, corrosion characteristics were evaluated through immersion tests, with this composition exhibiting optimal values. The findings underscore the potential of FSP in tailoring the properties of magnesium alloy composites for various industrial applications.

Key words: Friction Stir Processing, Tool parameters, Mechanical properties, corrosion behavior and microstructures

Material used: Magnesium AZ91 Alloy as base metal plate, Silicon Carbide, Aluminium Oxide and Graphene as nano ceramic particles as composition.

DIAGRAMATIC REPRESENTATION:

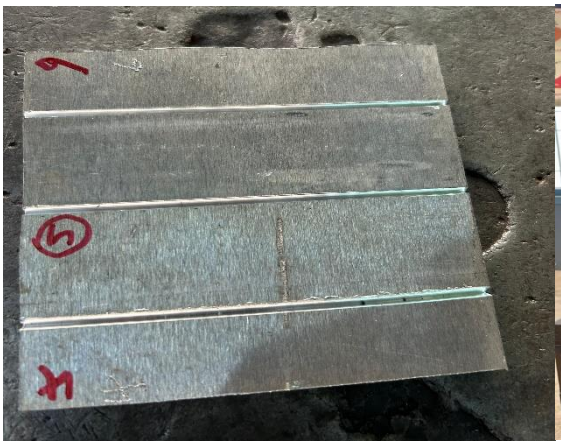
The following figures shows the fabrication of AZ91 composite produced through friction stir processing.



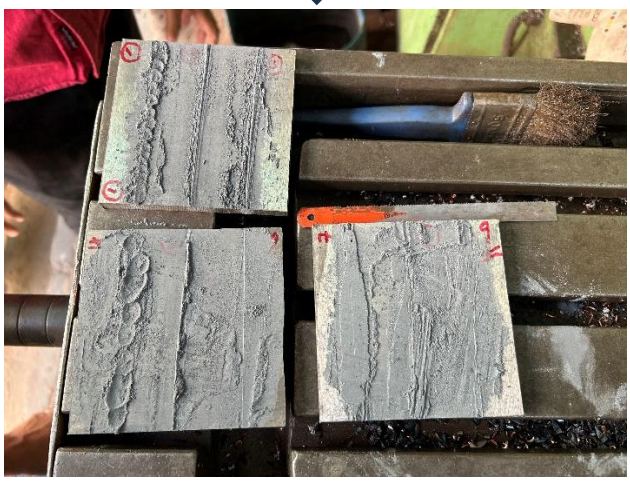
Magnesium AZ91 base plate

Nano powder compositions in three different proportions

Blending of compositions for homogenous mixture



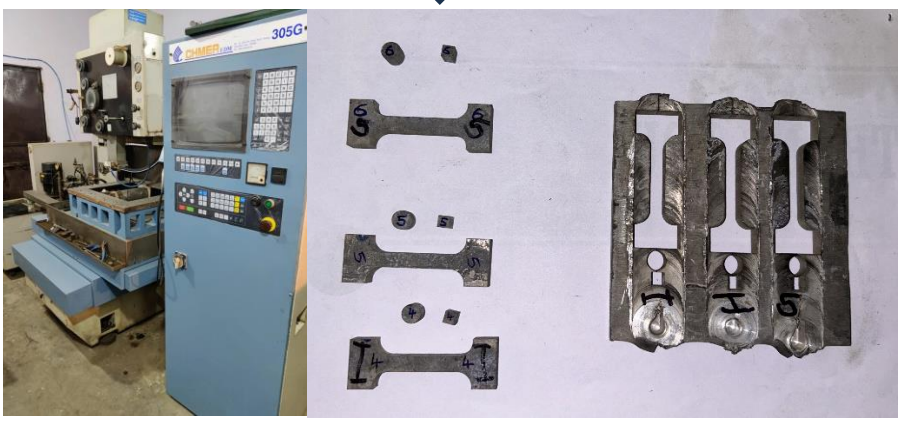

Groove making on Shaper Machine



Filling grooves with nano powder mixture

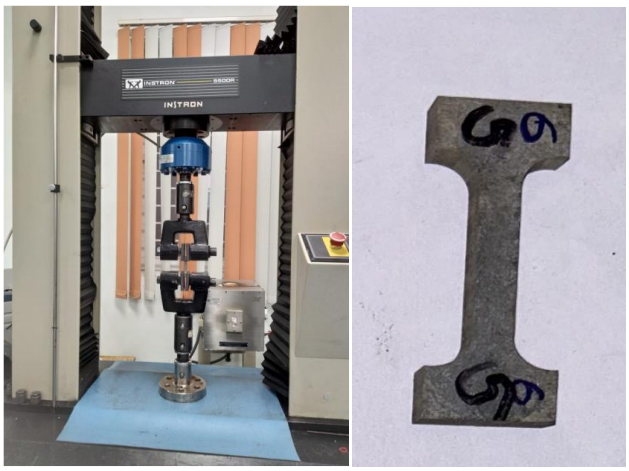
Friction Stir Processing on vertical milling machine

After FSP composite specimen

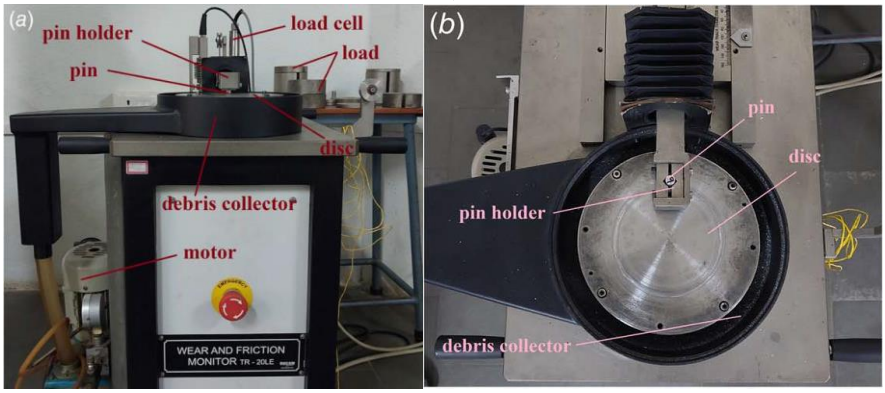


WEDM and Wire cutting of Specimen

Brinell Hardness Tester and microscope



Tensile Testing Machine And Specimen



(a) Wear Testing Machine and (b) Workpiece attached to pin holder