PAPER ID:181

DUCTILITY IMPROVEMENT OF COMMERCIALLY PURE ALUMINIUM THROUGH FRICTION STIR PROCESSING

Abhishek Kumar Jha[1], Md. Mofeed Alam[1], Shitanshu Shekhar Chakraborty[2], Kashif Hasan Kazmi[1], Prakash Kumar and Sumanta Mukherjee[1*]

[1]Production Engineering Department, BIT Sindri, Dhanbad, India

[2]Materials Processing and Microsystems Laboratory, CSIR-Central Mechanical Engineering Research Institute, Durgapur, India

* Corresponding author

ABSTRACT

Commercially pure Aluminium (cp-Al) is a common structural material whose ductility is not very impressive (percentage elongation at break ~ 10%). This paper reports Friction Stir Processing (FSP) as a method to improve the ductility of cp-Al without compromising the strength and hardness of the material. A non-consumable tapered cylindrical tool made of H13 steel was used to for the FSP treatment. Different combinations of process parameters, namely, 560 -900 -1400 RPM tool rotational speeds (RS) and 100-160- 200 mm/min tool traverse speeds (TS) were explored to identify the influence of those parameters on the strength, ductility, and hardness of the material. Tensile testing of the transverse specimens were performed to evaluate the ultimate tensile strength (UTS) and percentage elongation at break, and the microhardness values of the processed samples were measured across the processes zones. Although more than 25% improvement in the UTS and more than 80% improvement in the percentage elongation at break as compared to the native material were observed in tensile testing of different specimens, there was no monotonic relationship between the mechanical properties and the processing parameters within the investigated range. Therefore, Grey Relational Analysis (GRA) was carried out to find out the optimum parameter combination using which the most suitable combination of strength, ductility and micro-hardness can be achieved. From this analysis, the combination of 1400 RPM RS with 160 mm/min TS was identified as the optimized processing condition that can result in up to 81.4% improvement in percentage elongation at break with 12.9% improvement in the UTS and 7.27% improvement in the microhardness as compared to cp-Al. Finally, a quadratic regression model was developed to establish a relationship between the quality responses, viz. strength, ductility and micro-hardness, and the input parameters, i.e., rotational speed and traverse speed.

Keywords: Friction Stir Processing (FSP). Ductility of commercially pure Aluminium. Grey relational analysis. Regression analysis.