Journal of Materials Processing Technology 240 (2017) 68–76

Contents lists available at ScienceDirect

Journal of Materials Processing Technology

journal homepage: www.elsevier.com/locate/jmatprotec

Effect of polygonal pin profiles on friction stir processed superplasticity of AA7075 alloy

1. Introduction

Friction stir processing (FSP) is a solid state process employed to alter the mechanical and metallurgical properties of materials such as aluminum, copper, and magnesium. FSP is one of the variant of friction stir welding (FSW) which uses basic principle of FSW (Mishra and Mahoney, 2004). Fig. 1 displays the working principle of FSP in which non-consumable rotating tool plunges into a workpiece, traversed in the processing direction and finally retracted from the workpiece.

During the process, FSP tool induces intense plastic deformation of the workpiece. The tool geometry mainly consists of shoulder and pin, which are responsible for frictional and plastic deformation of workpiece respectively (Patel et al., 2016c). The FSP region is divided into two different zones i.e. stir zone (SZ) and thermo-mechanically affected zone (TMAZ). The SZ consists of fully recrystallized, equiaxed, fine grain microstructure due to shearing and mixing of work material around the tool pin (Behnagh et al., 2012; Charit and Mishra, 2003). Recently FSP has shown potential for applications such as surface composite manufacturing (Sharma et al., 2015), fatigue life improvements of MIG welds (Borrego et al., 2014; Costa et al., 2014), grain refinements (Patel et al., 2016d; Thompson et al., 2013), and superplasticity (Patel et al., 2016c).

Superplasticity is an ability of material to achieve more than 200% uniform elongation under tensile loading. Hence, superplastic materials offer designer and manufacturer to produce complex shape components by using various types of materials including low joint strength aluminum alloys such as AA7075. The fine-grained microstructure is a preliminary requirement to obtain superplasticity. However, the fine-grained microstructure is mainly unstable at the higher temperature, which results into degraded superplasticity (Charit and Mishra, 2005). Hence, in order to achieve superplasticity, a stable fine-grained microstructure at higher temperature is necessary. The FSP has been have been investigated for superplastic behavior in different aluminum alloys. Babu et al. (2014) reported superplasticity of the friction stir processed Al–4.5 Mg–0.35 Sc–0.15 Zr alloy; Pradeep and Pancholi (2013) produced superplastic bulk area by multipass FSP in aluminum alloy; Smolej et al. (2014) produced Superplasticity in friction stir processed Al–4.5 Mg–0.35 Sc–0.15 Zr alloy.

The AA7075 alloy is high strength alloy among Al alloys which is extensively utilized for aerospace applications because of its high strength to weight ratio, good fracture toughness and high resis-

* Corresponding authors.
E-mail addresses: profvvp@yahoo.com (V.V. Patel), vishvesh79@yahoo.com (V. Badheka).

http://dx.doi.org/10.1016/j.jmatprotec.2016.09.009