PLASTIC DEFORMATION MECHANISMS OF MAGNESIUM MATRIX NANOCOMPOSITES ELABORATED BY FRICTION STIR PROCESSING

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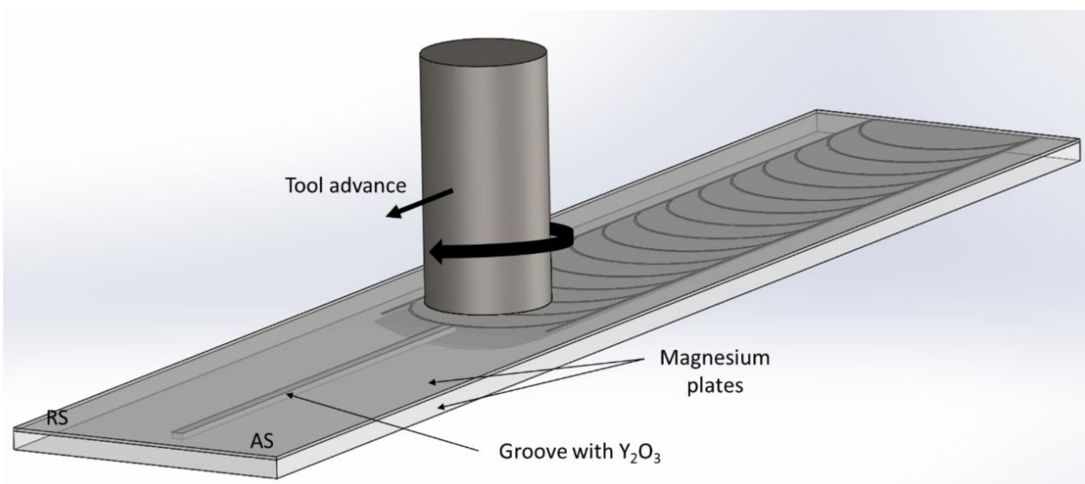
Magnesium based nanocomposites have attracted much attention over the past few years as a promising solution to lightweighting, energy saving and emission reduction, especially for automotive and aerospace applications. With a specific weight of 1.74 g.cm^{-3}, magnesium is the lightest of all structural metals. However, the strength of magnesium needs to be improved in order to compete with other light metals such as aluminum and titanium. A solution for this would be the reinforcement of magnesium or its alloys with oxide nanoparticles.

Several studies have been carried out on the deformation mechanisms of pure magnesium single crystals (Obara, Yoshinaga, & Morozumi, 1974) (Kelley & Hosford, 1967) (Lilleodden, 2010). However, to the author's knowledge, there are no significant studies on the deformation mechanisms of magnesium based nanocomposites reinforced with oxide particles. The use of magnesium as a structural material demands hence a fundamental study of the role of nanoparticles on the deformation mechanisms of magnesium. Plasticity of magnesium, which has a hexagonal closed-packed crystalline structure, is characterized by a very strong plastic anisotropy as well as a complex twinning activity. It is then important to understand how these nanoparticles will interfere with slip and twinning.

The aim of the present work is to investigate the single crystalline plastic behavior of magnesium based nanocomposites reinforced with Y_2O_3 nanoparticles. The choice of single crystalline specimens is motivated by the idea of eliminating the effects of grain boundaries and strain incompatibilities and thus isolating the role of particles in the strengthening mechanisms. The plastic deformation of these nanocomposites will be compared to the one of pure magnesium single crystals for different relevant crystallographic orientations.



Schematics of the friction stir processing. Advancing side (AS) and retreating side (RS).