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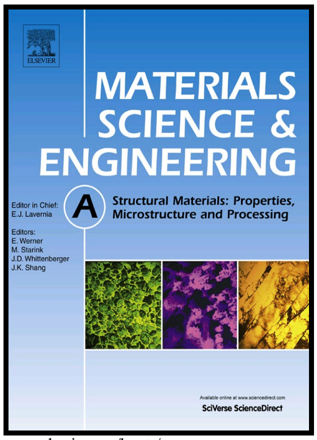

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Effect of the dynamic evolution of dislocations under cyclic shear stress on damping capacity of AZ61 magnesium alloy

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Abstract: The effect of the dynamic evolution of dislocations under cyclic shear stress on damping capacity of AZ61 magnesium alloy was investigated by using dynamic mechanical analysis and transmission electron microscope. The results indicate that the dynamic evolution of dislocations of AZ61 magnesium alloy exhibits four regions with the increase of cyclic shear stress, the first region is forced vibrations of dislocation segments pinned by weak pinning points, the second region is the dislocations breakaway from weak pinning points, the third region is dislocation multiplication and dislocation movement and the fourth region is dislocation pile-up. The dynamic evolution of dislocations significantly influences the damping capacity of AZ61 magnesium alloy, forced vibrations of dislocation segments pinned by weak pinning points dissipate the energy of vibration, which is responsible for the low damping capacity in the strain amplitude weakly dependent region; dislocations breakaway from weak pinning dissipate the energy of vibration, which is responsible for the linear increase of damping capacity in the strain amplitude strongly dependent region; dislocation multiplication and dislocation movement in the shear stress acting plane lead to the non-linear increase of mobile dislocation density, and they dissipate a large amount of the vibration energy, they are the direct factors in non-linear increase of damping capacity(the growth rate of the damping capacity increases as the increase of strain amplitude) and high damping capacity of AZ61 magnesium alloy; At last, because dislocation pile-up causes that the mobility of the dislocation lines decreases, the growth rate of the damping capacity of AZ61 magnesium alloy decreases.

Key Words: Magnesium alloy; Damping capacity; Dislocation; Shear stress; Strain amplitude; Multiplication

1. Introduction

Magnesium alloy is a kind of light weight structural material; it has excellent damping capacity as well as good mechanical properties. It is considered to be the most promising metal in automobile. The results show that damping mechanism of magnesium alloy at room temperature is dislocation damping mechanism [1]. Currently, a classic theory to illuminate the dislocation damping mechanism is the Granato–Lücke dislocation damping theory (G-L theory) [2-3], in which the dislocations string forced vibration and breakaway of dislocations from weak pinning points are employed to illustrate the dislocation damping mechanism. Some scholars[4-7] have studied the damping capacity of magnesium and magnesium alloys in the region of strain amplitude strongly dependent, the results have shown that there are obvious difference between the growth rate of the damping capacity in a higher strain amplitude region and the growth rate of the damping capacity in a lower strain amplitude region, meanwhile, the studies [8-10] have shown that dislocation movement and density of mobile dislocation are the direct factors in influencing damping capacity of magnesium and magnesium alloys, and Wan [4,11] considers the dislocations in magnesium alloys are very easy to slip even under small stress, the dislocations can not only vibrate stringily but also generate short-range slip under the cyclic stress, they influence the damping capacity together, and considers the large dislocation strain under higher stress could play a role of the deviation from the straight "G–L" plot. Therefore, previous studies show the stress acting on dislocations and the dynamic evolution of dislocations influence damping capacity of magnesium alloy, especially under high stress.

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