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# Combined effects of cooperative grain boundary sliding and migration and reinforced particles on crack growth in fine-grained Mg alloys

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**Abstract** A theoretical model is developed to describe the combined influences of cooperative grain boundary (GB) sliding and migration and reinforced particles on crack propagation in fine-grained Mg alloys. The numerical solutions of singular integral equations are derived on the basis of complex variable method of Muskhelishvili, the superposition principle of elasticity and distributed dislocation technique. The expressions of stress intensity factors (SIFs) near the right tip of basal crack are obtained and the energy release rate (ERR) characterizing the condition for crack growth is calculated. The influences of important parameters such as the location of cooperative GB sliding and migration, the size of reinforced particle and the misorientation angle of higher angle grain boundaries on the ERR are discussed in detail. The results show that the fracture toughness of fine-grained Mg alloys can be improved by cooperative GB sliding and migration and particle hardening and refining. There exists an optimum particle size that makes the fracture toughness of fine-grained Mg alloys best. Besides, the GB migration remarkably contributes to the fracture toughness of fine-grained Mg alloys and there is an optimum migration distance making the fracture toughness of fine-grained Mg alloys best.

**Keywords:** Grain boundary sliding; Grain boundary migration; basal crack; reinforced particle; fine-grained Mg alloys; energy release rate

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