Grain Boundary Engineering in polycrystalline materials

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The manipulation of microstructure to obtain desires properties is one of the fundamental goals of the field of materials science and engineering. The grain boundary faceting-defaceting transition on facets and roughening transition on grain boundary ridges presents the possibility of modify the grain boundary properties by heat without changing the grain orientations. If a grain boundary is rough, its structure and properties will be nearly isotropic with respect to both the misorientation angle between the grains and the boundary plane. Therefore, if all grain boundaries in a polycrystal are rough, they will have nearly uniform structures and properties. The specimens that will be quenched from high temperatures will show that the rough boundary structures can be largely retained during cooling without developing kinked structures. On the other hand, if the heat-treatment temperatures below the roughening or faceting transition temperatures of most of the boundaries, the grain boundaries will develop flat segments and ridges to produce singular structures. It is thus possible to produce either quenched rough or singular grain boundaries by simply heat-treating the grain boundaries at temperatures above or below phase transition temperature for most of the grain boundaries. The grain boundary faceting-defaceting and roughening transition may have important implications for obtaining the grain boundaries with desired structures and properties.

The authors acknowledge the partly financial support from the Russian Foundation for Basic Research (contract 16-03-00248 and № 17-43-500203).