Grain Boundary Roughening Transition in Ceramics

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The roughening transition of crystal surface has been extensively studied both theoretically and experimentally The surface step free energy decreases continuously with increasing temperature to 0 at the roughening transition temperature The singular surfaces have flat shapes while the rough ones have curved shapes for crystals of finite size The shape changes of the general grain boundaries in polycrystals show that they also undergo roughening transitions Alumina doped with small amounts of CaO and SiO_2 shows flat grain boundaries between the basal planes of large grains and randomly oriented planes of small grains These grain boundaries are singular When MgO is added, they become curved, indicating their roughening transition In pure alumina, the grain boundaries are rough at high temperatures and some develop either flat, hill-and-valley, or kinked shapes at low temperatures, indicating their transition to singular structures The flat singular grain boundaries in $BaTiO_3$ also become rough when heat-treated in hydrogen The grain boundary roughening transitions also occur at high temperatures in polycrystalline Ni and other metals, and have critical effects on grain growth, triple junctions, grain boundary diffusion, grain boundary sliding, sintering, and grain boundary precipitation These observations indicate that the grain boundaries, like surfaces, exist in either singular or rough state.

Future Outlook of Refractories for Blowing, Refining and Casting of Steel

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Production processes and resulting qualities of refractories for making steel have made substantial progress in the last 20 years to meet ever increasing demands of steel industry The progress has, however, been on the horn of a dilemma, countered by declining consumption of the refractories Such dilemma will continue in the foreseeable future as it has been the case in many materials industry sectors

There are yet many refractory problems left unsolved in steel industry Most of the unsolved problems in processing and quality of refractories need to be addressed not only by refractory industry but also by complementary optimization of relevant operation in steel industry Among them, the quality problems require intelligent solution, i e , advanced control of mineral phase, microstructure and texture, by implementing recent advances in ceramic science and technology Quantum leaps in the quality to revolutionary solve the problems by closer cooperation with steel industry and academia would assure further development of refractory industry

This presentation will briefly review some of key technological issues in the past progress of steelmaking refractories, and depict important unsolved quality problems with suggestion on possible direction of solutions