CERAMIC AND COLLOIDAL PROCESSING - EXERCISES

Prof. Paul Bowen
Dr. Andrea Testino
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<u>Exercises 13 - Solutions</u>

1. What are the effect of dopants and inclusions segregated at the GB on grain growth?

Solution

Dopants may be segregated at GB. If the diffusion of dopants does not match the GB movement, an asymmetric distribution of dopants occurs which can produce a drag force on the GB movement.
Similarly, inclusions hinder the GB movement, since an extra work must be performed, generating a retarding motion: pinning effect. A grain growth inhibition can be induced by small inclusions at a certain volume fraction (Zener relationship, slide 12).

2. What is the abnormal grain growth and which consequences does it generate?

Solution

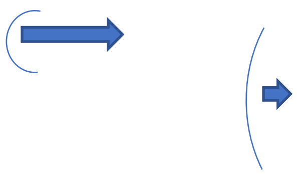
Grain growth can be normal and abnormal. Abnormal growth generate inhomogeneous microstructure characterized by few large grains surrounded by many smaller grains. Inhomogeneous microstructure means inhomogeneous properties. In addition, abnormal growth occurs because of fast movement of GB and pores can be trapped in the grain core; their segregation is therefore very difficult. In such a case, high densification cannot be achieved.

3. Describe the stability and the evolution of a pore based on its shape

Solution

See slide 17. The pore evolution can be interpreted base on the curvature. Case (a) the pore will shrink (concave); case (c) pore will expand (convex) and case (b) stable shape.
Remember: direction of the GB toward the center of the curvature

High curvature => high driving force => high speed



4. Describe the major characteristics of liquid phase sintering, the stages, and some examples of ceramic processing where LPS is applied

Solution

LPS is largely used as ceramic deification process, for instance for producing ceramics which have a very high melting temperature (and therefore a very high sintering temperature). The liquid phase allows densification at much lower temperature. Liquid phase needs to wet the solid particle, it cosuld be a viscous glass as well as a metal (cermet). The use of a liquid phase introduce an additional "degree of freedom" in the material design and property tailoring. LPS can be described following an initial rearrangement stage, followed by a solution-precipitation stage and a final stage.

5. What is the driving force in LFS?

In contrast with solid state sintering, where solid-gas interface is minimized, in LFS the solid is not in contact with a gas phase since it is completely wet by the liquid phase. Here the liquid-gas interface need to be minimized. Therefore, pores inside the body undergoes sintering generate a strong driving force which lead to densification.