EXPERIMENT 5

Subject

Sintering

Objective

To learn the mechanism of sintering process and parameters.

Theory

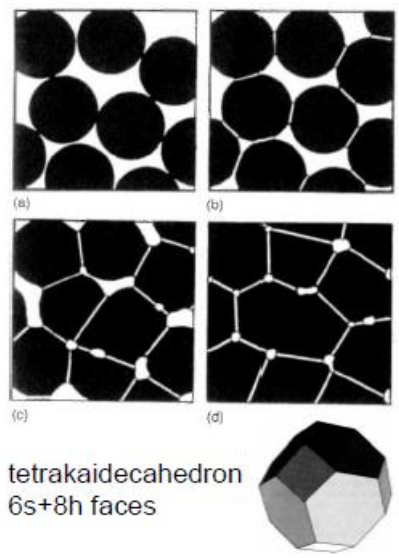
Sintering is defined as removal of pores between particles accompanied by shrinkage (densification) and grain growth.

For sintering to occur, there must be a decrease in the free energy of the system. The curvature of the free surfaces and, when used, the applied pressure provide the main motivation or driving force for sintering to occur. However, to accomplish the process within a reasonable time, we must also consider the kinetics of matter transport.

Driving force for sintering: reduction of surface area and lowering of surface energy. High energy solid-gas surfaces are replaced by low energy solid-solid interfaces (grain boundaries). In hot-pressing and hot isostatic pressing an additional driving force is provided by the external stress/pressure

Stages of Sintering

Sintering is normally thought to occur in three sequential stages referred to as (1) the initial stage, (2) the intermediate stage, and (3) the final stage.



(a, b) Initial stage sintering. Formation of strong bonds and necks between particles at the contact points. Moderate decrease of porosity (initial 40-50%) from particle rearrangement.

(c) Intermediate stage sintering. The size of the necks increases and the amount of porosity decreases. The sample shrinks (the centers of the grains move towards each other. The grains transforms from spheres to truncated octahedra (tetrakaidecahedra). This stage continues until pores are closed (r.d. 90%).

(d) Final stage sintering. Pores are slowly eliminated and major grain growth can occur.

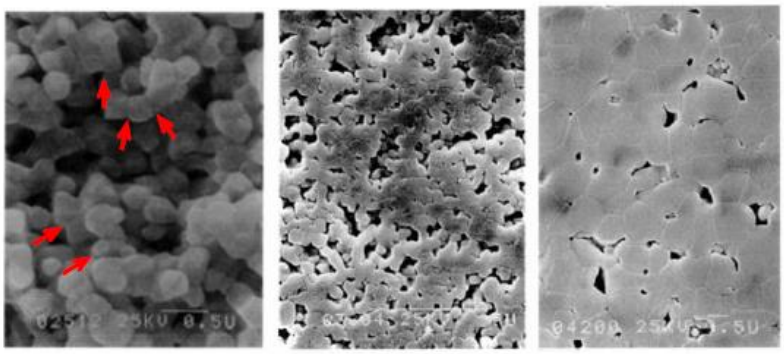


Figure 1. Image of typical sintering stages of ceramic powders.

Factors Influencing Sintering

Particle size: Materials transport over smaller distances, higher surface energies. Larger grains grow at the expense of smaller ones. Coarsening of the grains.

Particle packing: Improves the number of ontact points between particles. Relative density increased. Faster densification, less volume shrinkage.

Particle shape: Irregular shaped particles with higher surface area/volume ratio, have a higher driving force for sintering. Particles that pack poorly sinter poorly.

References of Theory

Rahaman, M.N., "Ceramic Processing and Sintering", Second Edition, 2003

Content of the Report

- Use report cover page template fort the first page of report. (You can download from web site of department)
- Every page should have page number. Text size should be 12 punto.
- Please give brief information about ceramic processing from powder to final product.
- Briefly explain the experiment's aim and theory with your own words.
- Draw a typical temperature profile graph for ceramic powder sintering.
- You can use photos that taken from experiment day in your report.