Sintering Mixtures in the Stage of Establishing Chemical Equilibrium

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The Principal deficiency of the existing notion about the sintering-mixtures consists in the fact that almost no attention is focused on the Phenomenon of alloy formation during sintering, its connection with dimensional changes of powder bodies, and no correct ideas on the driving force for the sintering process in the stage of establishing chemical equilibrium in a system are available as well. Another disadvantage of the classical sintering theory is an erroneous conception on the dissolution mechanism of solid in liquid. The two-particle model widely used in the literature to describe the sintering phenomenon in solid state disregards the nature of the neighbouring surrounding particles, the presence of pores between them, and the rise of so called arch effect.

In this presentation, new basic scientific principles of the driving forces for the sintering process of a two-component powder body, of a diffusion mechanism of the interaction between solid and liquid phases, of stresses and deformation arising in the diffusion zone have been developed. The major driving force for sintering the mixture from components capable of forming solid solutions and intermetallic compounds is attributed to the alloy formation rather than the reduction of the free surface area until the chemical equilibrium is achieved in a system. The lecture considers a multiparticle model of the mixed powder-body and the nature of its volume changes during solid-state and liquid-phase sintering. It explains the discovered *S*-and *V*-type concentration dependencies of the change in the compact volume during solid-state sintering.

It is supposed in the literature that the dissolution of solid in liquid is realised due to the removal of atoms from the surface of the solid phase into the melt and then their diffusion transfer from the solid-liquid interface into the bulk of liquid. It has been shown in our experimental studies that the mechanism of the interaction between two components, one of them being liquid, consist in diffusion of the solvent atoms from the liquid into the solid phase until the concentration of solid solutions or an intermetallic compound in the surface layer enables them to pass into the liquid by means of melting. The lecture discusses peculiarities of liquid phase formation in systems with intermediate compounds and the role of the liquid phase in bringing about the exothermic effect.

At the frist stage of liquid phase sintering the diffusion of atoms from the melt into the solid causes the powder body to grow. At the second stage the diminution of particles in size as a result of their dissolution in the liquid draws their centres closer to each other and makes the compact to shrink. Analytical equations were derived to describe quantitatively the porosity and volume changes of compacts as a result of alloy formation during liquid phase sintering. Selection criteria for an additive, its concentration and the temperature regime of sintering to control the density the structure of sintered alloys are given.