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RESEARCH OF THE PROCESSES OF CERAMO-METALLIC COMPOSITES SINTERING

Ceramic-metal composites are perspective materials of modern technics. They have a number of valuable properties inherent as to ceramics (hardness, high toughness, small creep), and to metal (high thermal conductivity, electric conductivity, shock resistance). Composites on the basis of a ceramic matrix and metal filler are the most rational for applying in the designs testing shock, dynamic, compression loads with simultaneous influence of severe atmospheres, temperatures, radiation.

Technologies of creation of building composites develop in several directions [1]. We offer idea of reception of ceramic composites with the high contents of metal filler a method of moist pressing with afterbake and furnacing. Feature of an obtained material is that metal entered into it not only performs filler, but also participates in stages of gelation of a composite. At furnacing the ceramic weights containing aluminium filler, there are complex physical and chemical transformations. As a result of thermal destruction of minerals and partial oxidation of aluminium there are loose oxides [2 – 4]. Thus the dispersed phase - a solid solution is formed intermediate shallowly.

Studying of stages of sintering is necessary for revealing the basic processes occuring at furnacing, and also the factors influencing them. As at temperatures from 900 - 1300°C the sintering process runs with participation of the fluid phase reacting with solid, research of kinetics of sintering carried out a method of serial furnacing in the specified interval with step 50°C.

In a basis of researches the exponential equation connecting contraction of samples $\Delta l/l$ with by duration of process τ and temperature T is necessary [5]:

$$\Delta l/l = k \exp(-(E/RT))\ \tau n,$$

where k - a preexponential multiplier;

E - apparent critical increment of energy;

R - generalpurpose gas constant;

n - an index of sintering.

The mechanism of a sintering process judged on apparent critical increment of energy and an index of sintering.

One of the factors rendering essential influence on a sintering process, the quantity of the eutectic melt present in a material during furnacing is. At the materials containing from 10 up to 20 % of filler, reduction of an index n with propagation of temperature is observed, that, apparently, is connected to decrease of motive power. All indexes of sintering are in limits, characteristic for process of dissolution - the precipitation controllable by diffusion, and, hence, it is the basic process limiting speed of sintering of a composite.

The increase in a filler level has resulted in some decrease n in the ranks of with T = const. Thus condensation and contraction in the field of temperature 1250 °C practically

come to the end. Indexes *n* for the investigated temperature band speak about a generality of the mechanism of sintering of the materials containing 10 - 20 % of filler.

The major index of a sintering process - apparent critical increment of energy. As speed of sintering in isothermal conditions decreases in due course, size *E* it is necessary to expect during the moment corresponding to time of achievement of identical contraction at various temperatures of furnacing. Nevertheless for researched materials the given moment of time practically is not achievable. Therefore for calculation of apparent critical increment of energy used a method of not isothermal sintering [5].

To the analysis of sintering in not isothermal conditions applied the rate equation connecting shrinkage ratio *z* with temperature:

$$dz/d\tau = z\,k \exp(-(E/RT))\,(E/RT2),$$

where $z = l-(\Delta l/l) / (\Delta l/lmax)$,

($\Delta l/lmax$ - linear shrinkage at maximal temperature of furnacing).

In linear coordinates this equation looks like:

$$\ln(-\ln z) = \ln(-(k/v))-E/RT,$$

where v - heat rate of the furnace.

Sintering in each case proceeds two-stage: critical increment of energy of first stage E_1 changes over a wide range (from 140 up to 360 kJ/mole) depending on pressure of pressing (received results are given in table 1). Build-up of pressure of pressing results in more density packing of particles that complicates their moving to microvolumes on an incipient state of sintering and causes increase in apparent critical increment of energy. Critical increment of energy of the second stage of process depends on dispersity of a feed stock and does not depend on pressure of pressing and quantity of entered filler. Hence, critical increment of energy E_2 concerns immediately to process of dissolution – precipitation. The transition point corresponds to temperature of occurrence of a fluid phase in a multicomponent system. Transition temperature is equal 1413 K that proves to be true results of calculations of process of not isothermal sintering.

Thus, on sintering of researched composites in the greater degree, than other factors, influence particle size of a refractory phase and the contents of aluminium which in composition of weights promotes increase in quantity and decrease of melt viscosity. Kineticly process runs two-stage: till the moment of occurrence of a fluid phase in system the basic mechanism regulating sintering, rearrangement of particles of a refractory phase is; after formation of a fluid phase in system the main kinetic process becomes dissolution - precipitation. Presence of the relative dissolution of a solid phase in fluid proves to be true that the dense material can be received on the basis of the compositions containing up to 20 % of aluminium.

Table 1.

Influence of pressure of moist pressing Composites on critical increment of energy

Used Clay	Quantity Aluminium filler, %	Pressure of moist pressing, MPa	Critical increment of energy, kJ/mole	
			E_1	E_2
Gluhovetsry kaolin	20	5	155	208
	20	8	186	233
	20	20	358	236
Krasnojaru-zhskaya clay hallmark 1	20	5	136	175
	20	8	153	198
	20	20	297	326

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