THREE-DIMENSIONAL NUMERICAL SIMULATION OF GASLESS COMBUSTION MODES DURING SELF-PROPAGATING HIGH-TEMPERATURE SYNTHESIS OF CERAMIC–METAL COMPOSITES

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Abstract: A three-dimensional mathematical model was developed and numerical simulations were conducted for self-propagating high-temperature synthesis (SHS) processes in gasless combustion mode for systems containing both active reaction cells and inert particles. This model corresponds to SHS processes of ceramic–metallic materials, in which ceramic phase grains are formed during an exothermic chemical reaction and the metallic binder is added as chemically inert particles. The results of the numerical study revealed a strong dependence of the average and instantaneous combustion rate as well as the temperature inhomogeneities of the reacting medium on the particle size of the inert additive. The combustion wave is capable of passing between inert particles, the size of which is several times larger than the size of the active reaction cells. This demonstrates the potential for producing ceramic–metallic materials with a high metallic binder content.

Keywords: gasless combustion; SHS; ceramic–metallic composites; discrete combustion model

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Figure Captions

Figure 1 Different stages of the initial sample structure modeling; light gray spheres — chemically active cells; and dark grey spheres — chemically inert cells

Figure 2 Dependence of the average combustion wave velocity on the inert cell content: *1* — radius of inert cells is equal to 2; *2* — 4; and *3* — radius of inert cells is equal to 8. Dotted lines denote the combustion wave disruption in certain numerical experiments

Figure 3 Temperature field of cells within the central axial cut of the cylinder at an inert cell radius of 8: (*a*) inert content 10%; (*b*) 30%; and (*c*) inert content 50%

Figure 4 Temperature profiles and instantaneous velocity of the front propagation corresponding to 45 percent dilution with inert: (*a*) the diluent radius is equal to 2; (*b*) 4; and (*c*) the diluent radius is equal to 8

Figure 5 Temperature field of cells with 45 percent dilution with inert: (*a*) the diluent radius is equal to 2; (*b*) 4; and (*c*) the diluent radius is equal to 8

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