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NEW PHYSICAL PHENOMENAS BEHIND SHS

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The problems of new physical effects appearance accompanied chemical combustion processes (SHS and analogues) were discussed. Those are soft X-ray irradiation, non-thermal routes of energy dissipation, and conditions of quasi-adiabatic combustion [1].

In the previous studies of Dr. A.I. Kirdyashkin's group [2, 3] and ours [4] it is shown that by thermites combustion, and especially for high-energy / high enthalpy ones, the local energy release could be higher than the theoretical ones assuming only chemical interaction. Calcium in noticeable concentrations was found in the solid combustion residues of Al-Fe_2O_3 thermites.

It has been found that during the synthesis of $MgAl_2O_4$ spinel by the SHS method in the (MgO-Al_2O_3-$Mg(NO_3)_2$ $6H_2O$)-Al system with boron additives (1-4 wt. %), diamond phase is formed in the synthesis products. The composition and structure of the final reagents were confirmed by XRD, SEM, equipped with an EDAX local X-ray microanalysis system. IR spectroscopic analysis confirmed the formation of carbon, which has a diamond-like lattice of lonsdaleite with aggregated nitrogen defects similar to the lattice of detonation diamonds. The emission spectrum of the radiation of the SHS process, obtained using a high-resolution spectrometer, showed that the composition of the evolved gases includes mainly hydrogen. Low-intensity lines of Al and O with various degrees of ionization and He are observed. It is shown that under certain conditions low-energy nuclear reactions (boron-proton reaction) occured in the high-speed SHS processes in the combustion wave. Due to the chemical inertness of $MgAl_2O_4$ to carbon at high temperatures, carbon formed during the boron-proton reaction is retained in the pores and intergranular space of the spinel. Based on the obtained experimental data, the most probable mechanism of carbon formation in the synthesis products was proposed [5].

REFERENCES

[1] S.B. Krivit and H.L. Jay, Nuclear energy encyclopedia: science, technology, and applications, vol. 5. John Wiley & Sons, 2011.

[2] A.I. Kirdyashkin, V.G. Salamatov, Yu.M. Maksimov, R.M. Gabbasov, É.A. Sosnin, V.F. Tarasenko, "X-ray radiation in self-propagating high-temperature synthesis processes", Combust. Explos. Shock Waves, vol. 44, no. 6, pp. 729-731, 2008.

[3] I.P. Borovinskaya, A.A. Gromov, E.A. Levashov, Yu.M. Maksimov, A.S. Mukasyan, A.S. and Rogachev, Concise Encyclopedia of Self-Propagating High-Temperature Synthesis. History, Theory, Technology, and Products, Elsevier Inc., 2017.

[4] A.A. Gromov, A.M. Gromov, E.M. Popenko, A.V. Sergienko, O.G. Sabinskaya, B. Raab, U. Taipel, "Formation of calcium in the products of iron oxide–aluminum thermite combustion in air", Russ. J. Phys. Chem., vol. 90, no. 9, pp. 2104–2106, 2016.

[5] N.I. Radishevskaya, O.K. Lepakova, A.Yu. Nazarova, O.V. Lvov, V.D. Kitler, R.M. Gabasov, R.V. Minin, "Characteristics of phase formation during combustion of the MgO-Al2O3-Mg(NO3)2·6H2O-Al-B system", Ceram. Int., [in press] 2022. doi.org/10.1016/j.ceramint.2022.01.279.