Adjustment of the combustion mode in CuO/Al multilayer thermite materials

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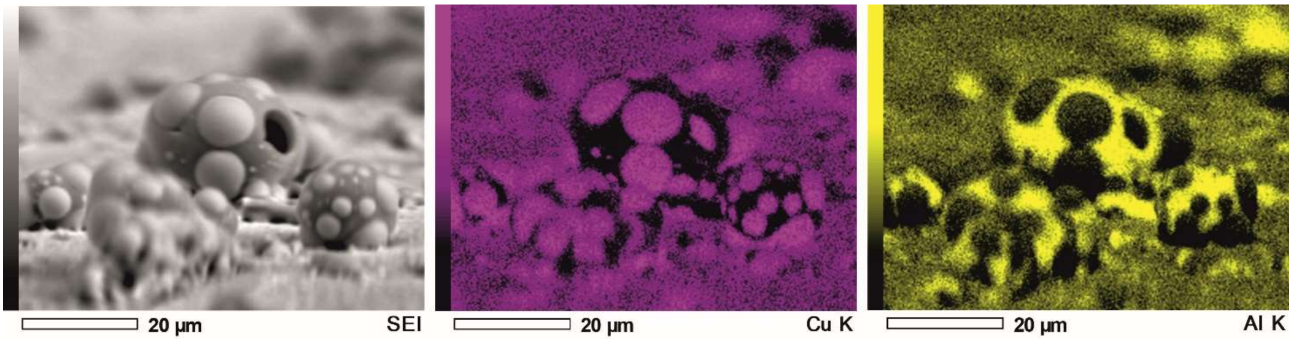
Multilayer thermite materials are a type of energy materials in which the fuel and the oxidizing agent are made in the form of alternating thin layers with a thickness from units to hundreds of nanometers. Such materials can be fabricated by traditional microelectronics methods - magnetron sputtering, electron beam, ion-plasma sputtering, etc. The formed laminated thermite materials can act as local heat sources and be used to bond surfaces, including heat sensitive components.

The most studied thermite materials are «aluminum–iron oxide» and «aluminum–copper oxide» pairs, which are characterized by large thermal effects and high adiabatic reaction temperatures of 4.1 kJ and 2843 K and 3.7 kJ and 3135 K respectively.

In the framework of this work, multilayer CuO/Al structures were studied, which were formed on the surface of various substrates (glass-ceramic or monocrystalline silicon) by magnetron sputtering. Sputtering of copper and aluminum oxide targets was carried out in an argon atmosphere. The samples differed in the ratio of component layer thicknesses and in the total thickness of the multilayer structure. Combustion was initiated using a spark from piezoelectric current source. The features of the combustion process were studied using high-speed video recording. The composition and geometric characteristics of multilayer structures were controlled using elemental analysis and electron microscopy (figure below).



SEM image of combustion products of a CuO/Al multilayer thermite structure

The possibility of adjustment the combustion mode of multilayer structures by changing the ratio of the thicknesses of the components was experimentally demonstrated - to change the intensity of gas evolution, to control the aggregate state of the reaction products after the reaction - solid, liquid or gaseous. An increase in the aluminum content in multilayer structures led to a significant decrease in gas evolution and an increase in the speed of propagation of the combustion front.

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