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Use of Nanosize Reactants in SHS Processes

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During the past few years, significant progress has been made in the formation of nanopowders from various compounds, including metals, oxides, carbides, and nitrides. The use of powders with small particle sizes (<100 nm) has not been significantly explored as a source of reactants in self-propagating high-temperature reactions. Since 1999, the South Dakota School of Mines and Technology has been involved in studies of combustion characteristics in systems consisting of nanosize aluminum, nickel, and/or various nanosize oxides of iron, titanium, molybdenum, tungsten, and copper. It has been demonstrated that the decrease in the size of reactants from few microns to tens of nanometers may increase, in some cases, the combustion front velocity by two orders of magnitude. In this paper, the use of nanosize aluminum and silicon powders in the synthesis of aluminum oxynitride and sialons is discussed. In addition, the formation of TiAl-Al_2O_3 nanosize composite material is presented. The effect of experimental parameters, such as average particle size, dispersing agents, mixing techniques, and preheating of reactants on the final composition and morphology of the products is discussed as well. Reactants and combustion products are characterized by TEM/STEM, SEM/EDX, XRD, BET, and TGA/DSC.