The main purpose of this work is to find a physical and numerical description related to the reaction of the multilayer nano energetic material (nEM) in dense film. Self-propagating high temperature reaction in nEM of dense thin film typically includes multilayer vapor deposition of a transition metal and an element. Energy density of nEM is much higher than the conventional energetic material; therefore, nEM finds more applications in propulsion, thermal batteries, material synthesis, nano igniters, waste disposals, and power generation. The two main interests in this study are propagation speed and maximum temperature of the reaction. The main aim in this study is to introduce a numerical model which estimates and relates these values in multilayer nEM in dense film of aluminum and copper oxide deposited on a composite substrate.

Flame front speed and the reaction heat loss were the initial targets. Time-of-flight technique has been developed to measure the speed of flame front with an accuracy of 0.1 m/s. This measurement technique was used to measure the speed of propagation on multilayer nEM over different substrate material up to 65 m/s. A controllable environment (composite silicon\silica) was created for the multilayer standard thin film of aluminum and copper oxide to control the reaction heat loss through the substrate. A numerical analysis of the thermal transport of the reacting film deposited on the substrate was combined with a hybrid approach in which a traditional two dimensional black box theory was used, in conjunction with the sandwich model, to estimate the maximum flame temperature. This work highlights an important finding that by increasing the substrate thickness, the quenching effect is progressively diminished at a given speed. These results also show that the average speed and quenching of flames depend on the thickness of the silica substrate and can be controlled by a careful choice of the substrate. In the last stage of this study, a numerical model was developed based on the moving heat source for multilayer thin film of aluminum and copper oxide over a composite substrate of silicon\silica. Thickness of the substrate, the length of flame front, and the density of the product were utilized for the standard multilayer thin film with 43 m/s flame front speed. Numerical model was also used to estimate three major variables for a range of 30-60 m/s. The maximum combustion flame temperature that corresponds to flame speed along with the length of the flame, density of the product behind the flame, and maximum penetration depth in steady reaction, were calculated.

Major: Mechaniccal /Thermofluid

Educational Career:
Bachelor's of Mechaniccal, BS, 2005, UCF
Master's of Mechaniccal, MS, 2007, UCF

Committee in Charge:
Dr. Ranganthan Kumar, Chair, Mechanical, Material, and Aerospace Engineering
Dr. Louis Chow, Co-Chair, Mechanical, Material, and Aerospace Engineering
Dr. Kevin Coffey, Mechanical, Material, and Aerospace Engineering
Dr. Ruey-Hung Chen, Mechanical, Material, and Aerospace Engineering
Dr. Bhimsen K. Shivamoggi, Mathematics
Dr. Saptarshi Basu, Mechanical, Material, and Aerospace Engineering

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The public is welcome to attend.