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Development of on-chip initiation and measurement method for flame velocity self-propagating of thermites

Electrically triggered detonation of patterned energetic materials were performed to determine the propagation velocity of nano-scale thermite composites comprising of Copper oxide (CuO) and Bismuth oxide (Bi_2O_3) with Aluminum (Al). The burn rates were measured by monitoring the change of resistance of a thin Platinum film, deposited on a glass substrate by sputter coating, due to detonation of the thermite. A high time resolution was attained by using a NI Labview based sampling at 1 MHz frequency. We have measured burn rates as high as 800m/sec for CuO-Al nanoparticle dispersions using this method. For Bi_2O_3-Al nanoparticle dispersion the highest burn rate is measured to be 155m/s. The method provides a repeatable way of flame velocity measurement in a laboratory scale for characterization of nano-energetic materials at a much lower cost than other systems prior to this. Most have used very expensive high-speed cameras for the same task. The detonation initiation aspect of the system deals with the fabrication of a chip with a low-resistance thin-film heater, suitable for initiation of the self-propagating thermite reaction. This system achieved on-chip ignition of nano-scale thermites with a supply voltage as low as 3V. The approach is novel because thermites typically require high-power supply to initiate self-propagating reactions. Thermite materials can be used in primers for detonating high-explosives, micro-thruster devices, smart ammunitions, smart bombs, power generations, etc. and in all these applications, initiation of a thermite reaction is one of the major key components. The on-chip thin film heater, like the speed measurement component will serve the purpose and is a low-cost alternative and can be easily produced on a large scale.