

Nanoenergetics, a new technological area through the integration of nanothermite into micro-scale devices

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CHNO-based energetic materials such as TNT, RDX, and HMX are attractive sources of reliable and “dormant” energy able to very quickly deliver gas, heat, chemical species or, after conversion, electrical power. The decomposition of the well-known TNT can produce ~4 MJ/kg while a modern chemical lithium battery only stores 0.5 MJ/kg. With long shelf life, CHNO energetic materials can provide fast reactions with high energy densities, thus enabling autonomous actions. In practice however, they can be unsafe, unstable and there is no single material that would excel to provide multiple type of actuations, in response to contradictory or diverging requirements: rapid or slow energy release, high or low amount of gas generated ...

In the late 90's, nanotechnologies met the energetic materials field leading to the birth of a new technological area, namely *nanoenergetics*. This enabled the emergence of a new class of safe energetics called *nanothermites*. Nanothermites feature an oxido-reduction reaction involving aluminum in contact with a metallic oxide such as CuO, Fe₂O₃... Compared to conventional CHNO pyrotechnical materials, nanothermites are attracting much attention due to their high enthalpy of reaction (up to 5 MJ/kg, 16 kJ/cm³), adiabatic flame temperature (> 2600 °C) and environmentally benign products. Rapidly, researchers have been discovering that *nanoenergetics*, and specifically nanothermites, are particularly well-suited for microdevice applications to deliver very efficient combustion rates with unprecedented potential to customize the reaction for a given and specific application. Their high level of tunability and superior reaction performance in microscale systems makes nanothermites a powerful solution for a variety of applications including *microthrusters*, *microactuators*, *microdetonators*, *pulse power generators*, *propellant initiators*, and *multipoint initiators*. Nonmilitary applications of nanothermites include *airbag inflation initiators*, *electrothermal switches*, *needle-free syringes*, *powder injectors*, *transfection devices*, and others.

During the seminar, Carole Rossi will make an brief overview of nanoenergetics technological area, focussing of the application and potential innovations, before discussing scientific issues to be addressed to bridge the gap between research and applications.