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From spray flash evaporation to spray flash synthesis: the case of ADN

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Abstract Synthesis of organic and inorganic compounds and materials requires up to now in the most cases discontinuous techniques, which on industrial needs represent big quantities often confined in big batches. This matter of fact makes that such syntheses with energetic as well as with non-energetic molecules, represent always some danger. This risk can be mitigated by introducing two changes being the continuous synthesis and the local synthesis. These two concepts were first introduced by our laboratory through the invention of the Spray Flash Evaporation (SFE) technology awarded by the french Academy of Science[1]. This process starts with a superheated solution in which the different species to be crystallized, in form of nano- and submicronsized particles, are dissolved. The solution is then sprayed in an atomization chamber through a heated hollow-cone nozzle, which induces a very fast evaporation of the solvent and results in the crystallization of the particles. This highly versatile process permits to obtain, depending on the interaction types of the the different molecules, various nanocomposites structures such as crystalline dissociated or core-shell particles and even nanococrystalline particles in the case of hydrogen bonds or Pi-Pi stacking between the different molecules. SFE, even if it is a revolutionary process in terms of the produced structure types, the small particles, and also through its continuous character, leaves the pristine molecules unchanged and stable. Spray Flash Synthesis (SFS), although it has the same former advantages as SFE, however changes the game as it is in addition able to synthetize, new molecules, changing by the same way tremendously the deal in the chemical synthesis area! As SFS masters locally the synthesis of molecules in a continuous manner, it represents respectively to all until now, existing synthesis pathways, a major breakthrough!

SFE and SFS technologies will be first presented in this talk and different materials and nanocomposites obtained by these both techniques, will be described and their structures discussed. The benefits of both techniques will be shown compared to classical techniques used before for the different products obtained. A special focus on ADN will be given while insisting on its high sensitivities of its molten state.

On the same time, different material characterization challenges will be given and some results using new metrologies such as AFM-TERS spectroscopies obtained on different organic explosives as well on synthetized oxides used for nanothermites formulations, will be highlighted.

[1] D. Spitzer, Grand Prix Lazare Carnot, Académie des Sciences, 2015.