

AFM-TERS, SERS structure investigations of energetic and pharmaceutical nanomaterials produced by spray flash evaporation

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Abstract

In the last years, the NS3E laboratory developed the Spray Flash Evaporation (SFE) process to formulate pharmaceutical and energetic nanocomposites [1]. For these ultimate sized organic compounds, common techniques such as electron microscopy, energy dispersive X-ray spectroscopy, powder X-ray diffraction etc., reach their limits due to high energy inputs triggering dissociations of organic molecules or due to single crystal sizes below the resolution limits. However, a detailed knowledge of morphology and simultaneous of the chemical composition of these nanocomposites is of high relevance in order to optimize the engineering processes. Thus, Atomic Force Microscopy – Tip Enhanced Raman Spectroscopy (AFM-TERS), and SERS (Surface Enhanced Raman Spectroscopy) are applied to investigate chemical and structural properties of different nanocomposites.

Within this contribution, AFM TERS results of different weight ratios of 1,3,5-Trinitro-1,3,5-triazinane (RDX) and Trinitrotoluene (TNT) nanoparticle mixtures are presented. In this context, a completely closed core-shell arrangement of a 60 % RDX (core) and 40 % TNT (shell) mixture could be investigated [2]. Results were received by single point TERS spectra and visualized by AFM-TERS mapping, whereby a significant marker band was chosen for each compound.

Furthermore, co-crystal systems are under investigation with AFM-TERS. One of them consists of Hexanitrohexaazaisowurtzitane (CL 20) and 1,3,5,7-Tetranitro-1,3,5,7-tetrazocane (HMX) in a molar ratio of 2:1 (CL 20/HMX). Far-field Raman and AFM-TERS investigations prove the co-crystallinity of the system, since chosen marker molecular vibrations of pristine compounds are detectable homogeneously distributed within single nano structured particles [3]. At the end of the presentation, the investigations made by SERS on active pharmaceutical ingredients such as furosemide/PVP, will also be presented.

References

- [1] Spitzer D., Risse B., Schnell F., Pichot V., Klaumünzer M., Schäfer M.R., Scientific Reports, 4, 6576, (2014).
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