Nanoinnovation and drug-delivery: chemico-physical issues

Giuseppe PALADINI - *University of Catania*

Nanostructured materials have emerged as promising carriers for targeted drug-delivery, offering significant advantages in terms of enhanced therapeutic efficacy, reduced toxicity, and improved patient compliance. Investigations focused on the intermolecular interactions occurring between a specific nanocarrier and pharmacologically active compounds provide valuable information about the binding affinity, selectivity, structure, kinetics, and thermodynamics of the resulting supramolecular assembly, furnishing ground rules for the definition of optimized procedures capable to provide safe high-performance drug-delivery systems with enhanced therapeutic outcomes. Here, the chemico-physical characterization of a selection of nano-scale drug-delivery systems, ranging from cyclodextrin-based inclusion complexes to drug-loaded solid lipid/polymeric nanoparticles through both conventional and novel approaches, is presented. In particular, Fourier transform infrared spectroscopy in attenuated total reflectance geometry (FTIR-ATR) and Raman techniques were complementary employed to get insights into the intermolecular interactions occurring between the different molecular components, starting from the analysis of the spectral changes induced by the complexation or drug-nanoparticle encapsulation processes on characteristic vibrational bands. Furthermore, the results of a 2D correlation spectroscopy (2D-COS) FTIR-ATR analysis, for the first time applied to this class of materials, will be also addressed. Cutting-edge information, including the possibility to assess the sequential order of changes affecting functional groups and the different relative rates of spectral variations, not accessible through conventional analysis, will be provided. Such additional aspects further contribute to the development of next-generation drug-carriers and furnish, at the same time, a detailed scenario of the dynamical behavior exhibited by supramolecular materials upon external perturbations.