Poster

AN ANALYTICAL SPECTROSCOPY STUDY OF CHITOSAN NANOPARTICLES FOR DRUG DELIVERY APPLICATIONS

E. Ieva[a] *, A. Trapani[b], N. Cioffi[a], L. Sabbatini[a], A. Nacci[a]
[a]*Dip. Chimica, Università di Bari, Bari -Italy*
[b]*Dip. Farmaco-Chimico, Università di Bari*
* e.ieva@chimica.uniba.it

Chitosan (poly[β-(1-4)-2-amino-2-deoxy-D-glucan], CS) is obtained by the alkaline deacetylation of chitin, a polysaccharide that is found in the exoskeleton of crustaceans, the cuticle of insects and the cell walls of most fungi.
Typical properties of CS such as high biocompatibility, biodegradability, and low-toxicity have motivated an intense research in different fields among which agriculture, food, pharmaceutical and biomedical [1]. Several applications of CS include its activity as plantar antivirus [2], hypolipidic dietary material [2], film-forming agent in cosmetics [3].
In the last two decades, CS micro- and nano-particles were investigated as novel carriers for sustained drug release. Remarkably, chitosan-based nanoparticles have shown an increase in the drug payload and bioadhesive properties and the enhancement in the oral bioavailability and intestinal absorption of proteins were also observed [4, 5].
In the present work, chitosan nanoparticles (CS-NPs) were prepared in presence of cyclodextrin according to a modified ionic gelation technique [6] with the aim to study the potential of such nanomaterial as oral vector for a model peptide, glutathione (γ–glutamylcysteinylglycine, GSH). The role of cyclodextrin is both to protect the GSH and to modulate the drug release. To the best of our knowledge, there is no GSH oral dosage form available, this peptide being administered only parentally.
CS-NPs were characterized by zeta potential measurements and their GSH encapsulation efficiency values were found equal to 25%. Furthermore, X-ray Photoelectron Spectroscopy (XPS) was carried out to explore the NPs surface chemical composition (table 1) and ion-etching assisted XPS provided information on the elemental in-depth distribution. High resolution S_{2p} XP spectra were recorded at different etch times and were used to calculate the depth-variation of the GSH concentration into the NPs. Typical spectra of the pristine and etched nanoparticles are reported in figure 1. The S_{2p} region of the pristine material is composed by only one doublet ($BE_{S2p3/2}$=167.9± 0.1 eV), due to the sulphonate chemical environment of the sulfo-butyl-cyclodextrin.
Ion-etching exposes inner parts of the particle and, after a 160 s etching, a second doublet becomes evident in the S_{2p} region. This feature, falling at low binding energy values ($BE_{S2p3/2}$=163.9± 0.1 eV), is attributed to S-H and/or S-S groups belonging to GSH and/or its dimeric species and can be easily used as a marker for the presence of the peptide [7].
Noteworthy, the relative abundance of the sulfo- and sulphide species changed during the in-depth analysis. In particular, the concentration of the latter functional group increased when inner layers were exposed. Curve-fitting data were used to calculate the GSH concentration anisotropy into the nanomaterial. GSH is more abundant in the inner layers of the nanoparticles, while the external NPs shell is formed by chitosan and sulfo-butyl-cyclodextrin, acting as a sort of protective coating for the pharmacologically active analyte.

References:

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Etch time /s	***C%***	***O%***	***N%***	***S%***	***Cl%***
0	65.2	29.2	3.3	2.0	0.3
160	66.3	27.3	3.5	2.6	0.3

Table 1. XPS elemental analysis recorded on chitosan nanoparticles as a function of the etching time. Error on the atomic percentages is ±0.3%.

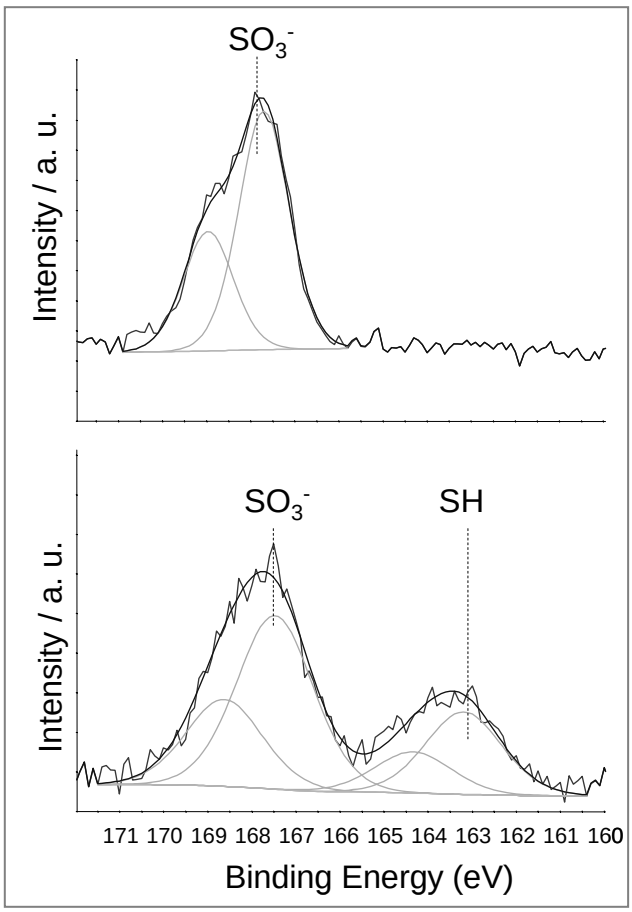

Figure 1. S_{2p} XP spectra relevant to the pristine (*upper panel*) and etched (*lower panel,* etch time = 160 s) chitosan nanoparticles. Doublet attribution is reported as a label of the $S2p_{3/2}$ peak.