RESONANCE LIGHT SCATTERING IN SOLID STATE AND BIOMOLECULAR SYSTEMS

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Resonance Raman Spectra of Antitumor Antibiotics and Their Complexes with DNA

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Recently resonance Raman scattering has been employed as a sensible and selective tool to study some antitumor antibiotics, as actinomycin and doxorubicin, which form intercalation complexes with DNA (1,2).

We have measured the Raman excitation profiles of actinomycin (3). Their analysis allowed us to establish the origin of the visible absorption bands as due to 0-1 vibronic transitions involving a single electronic state.

The resonance Raman spectra of actinomycin-DNA complex show remarkable changes in the band intensities with respect to the spectra of the pure drug. In particular, the band at 1505 cm^{-1}, which is the strongest one in the latter, completely disappears. Some variations in the excitation profiles of the most significative bands are also observed, allowing us to understand the structure of the absorption spectrum of the complex. In fact the red shifts of the excitation profiles maxima, nicely follow the bathochromic effect in the absorption spectrum. Its different pattern is essentially explained in terms of the missing contribution of the 1505 cm^{-1} band.

As doxorubicin is concerned, due to the strong red fluorescence, its Raman spectrum was measured only with the 475.9 nm exciting line. This spectrum is characterized by a strong structured band at 1440 cm^{-1} and by doublets occurring in the 1200 and 450 cm^{-1} regions respectively. These bands, on the basis of the analysis of the infrared single crystal spectrum of 1, 4-dihydroxyanthraquinone, have been assigned to skeletal stretchings, to coupled OH bendings and to C=O bending in plane respectively.

The vibronic assignment performed on the model chromophore 1, 4-dihydroxy-anthraquinone allowed us to interpret the complex pattern of the visible absorption band of the drug. From the above results it was possible to evidentiate the modes, responsible of the progressions in the electronic spectrum, which give rise to the main Raman bands.

The most striking differences in the Raman spectrum of doxorubicin-DNA complex consist in the strong intensity decreasing of the 1440 and 446 cm^{-1} bands together with a smaller one for the 1212 cm^{-1} band. Also in this case, the variations are easily correlated with the changes observed in the visible absorption spectrum, where all the subpeaks shift to higher wavelengths, while only the highest frequency maximum is weakened in intensity. This maximum appears due to the overlapping contribution of the first term of three progressions: 455 + n1215, 455 + n1330 and 455 + n1400 cm^{-1}. Therefore we can affirm that the modes ν(C=C), δ(OH) and δ(C=O) of the  groups are affected in the excited electronic state, by the formation of the complex.

In conclusion, the results obtained for these two antitumor agents indicate that the formation of intercalation complexes with DNA can be emphasized by vibronic spectroscopic methods. In fact, the occurrence of the interaction is characterized by hypochromic and bathochromic effects, connected with intensity decreasing or the disappearance of some Raman bands.

References

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