SERS quantitative determination of organic dyes: The role of physicochemical properties and intermolecular forces

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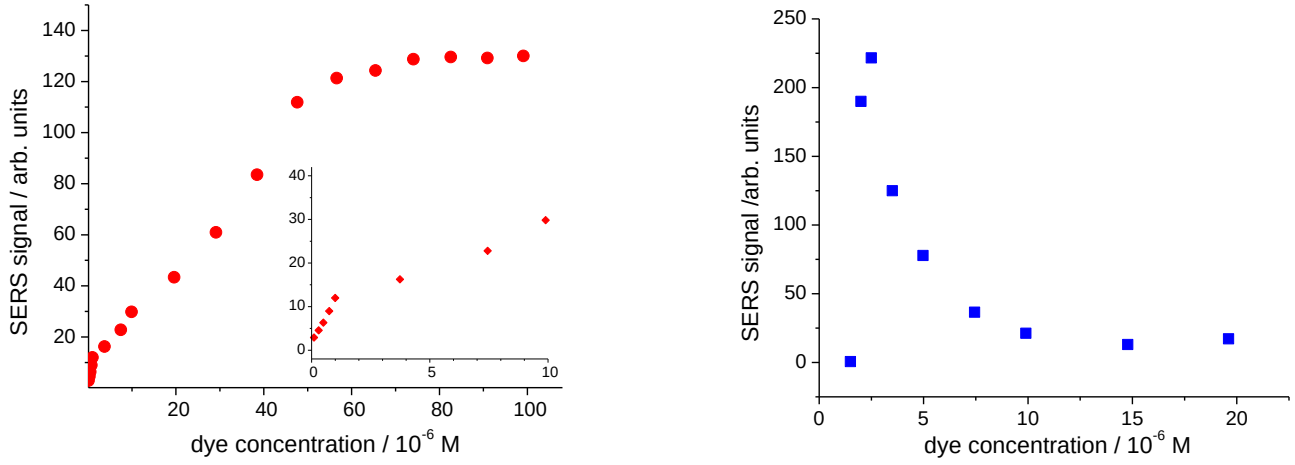
The use of SERS methods for the determination of different molecular species is not trivial and many parameters seriously affect the outcome of any experiment. In this work, we investigate the role of different molecular properties to the modulation of the SERS signal, the useful dynamic range for the determination, the dynamics of the molecule-nanoparticle process and the time stability of the signal.
The possible application of SERS methods for the identification of organic dyes present in works of art, textile fibers and other materials has been already presented and reviewed.[1] More critical is the possibility to obtain a quantitative determination of the analyte by SERS techniques because many parameters strongly affect the measured signal. Quantitative information, at least in relative terms, is crucial for the study of dye mixtures. Most of the research work on the potential of SERS for quantitative determination of the analytes has been focused on the low detection limits, down to single molecule experiments. Only recently, a few publications have introduced the possibility of SERS use for this purpose and properties of binary or more complex dye mixtures have been investigated.[2]
This work aims to clarify a few fundamental issues relevant for the determination of dyes content by SERS spectroscopic methods. The key points we will try work out are related to the nature of the molecule substrate interaction, and the experimental problems possibly arising for the quantification of dyes absorbed on metal nanoparticles. We have experimentally studied the SERS signals obtained preparing colloidal dispersions of silver nanoparticles with different concentration of ordinary organic ionic dyes (alizarin anion and both safranin and rhodamine 6G as cationic dyes). Different trends for the change of the SERS signal with analytical dye concentration have been obtained as well as different kinetic processes.



The alizarin anion (left panel) and safranin SERS signals at 785 nm excitation as a function of the analytical dye concentration in solution. The signals are normalized for laser power and integration time.

References

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