Fluorescence and Raman characterization of a transport system formed by the anti tumoral drug emodin, silver nanoparticles and porous silicon

Paz Sevilla[1,2], Margarita Hernandez[2], Gonzalo Recio[3], E. Corda[2], Raúl J. Martín-Palma[3], José V. García-Ramos[2], Concepción Domingo[2]

[1]Dep. Química Física II, Facultad de Farmacia, UCM, 28040 Madrid, Spain
[2]Instituto de Estructura de la Materia, CSIC, Serrano 121, 28006 Madrid, Spain
[3]Departamento de Física Aplicada, Facultad de Ciencias, UAM, 28049 Madrid, Spain.
paz@farm.ucm.es

Emodin is an orange crystalline solid that belongs to the anthraquinone family (fig. 1). It has shown anticancer effect in breast and prostate tumors. It presents high solubility in organic solvents but it is insoluble in water. To overcome this limitation design of advanced drug delivery systems are necessary in order to deliver the drug at the target site with the adequate rate and concentration.

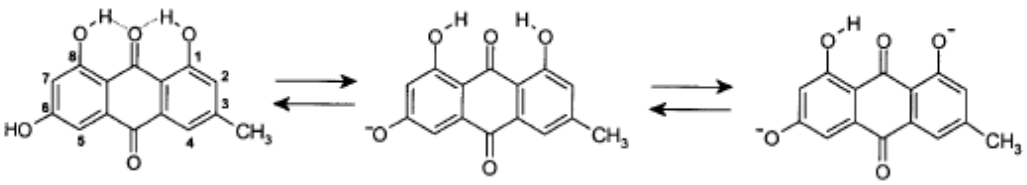

Figure 1. Structure and acid-base equilibrium of emodin

Between the new materials that have recently revealed a lot of promise in drug delivery, porous silicon (PSi) is an interesting one (fig. 2). It is biocompatible and biodegradable and is able to form micro devices to carry the drugs until the site of interaction [1-3]. If the molecules do not remain inside the pores it is necessary to functionalize the silicon surface. As this is the case of emodin, we have solved the problem by using silver nanoparticles. These metal nanostructures present additional advantages derived from the Localized Surface Plasmon Resonances (LSPR) they support. The principal benefit is related with the obtaining of surface enhanced spectroscopy such as SERS (surface enhanced Raman scattering) and SEF (surface enhanced fluorescence) that can be used as potent and high sensitive techniques for molecular detection.

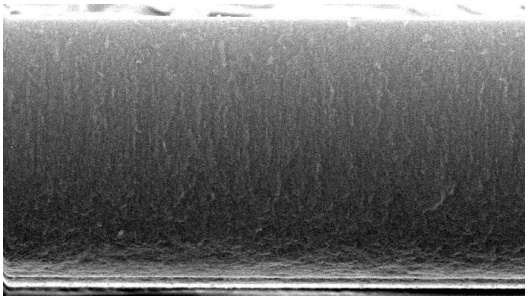

Figure 2. Cross section of a porous silicon layer

Understanding and knowledge of the physicochemical properties of the systems used to transport and release the drugs constitute a prerequisite in designing advanced drug delivery systems. Interaction of emodin with silver nanoparticles has been previously studied in our group [4-5]. In the present work we have used Raman and SEF spectroscopy to perform a characterization of emodin adsorbed on silver nanoparticles and loaded on PSi.

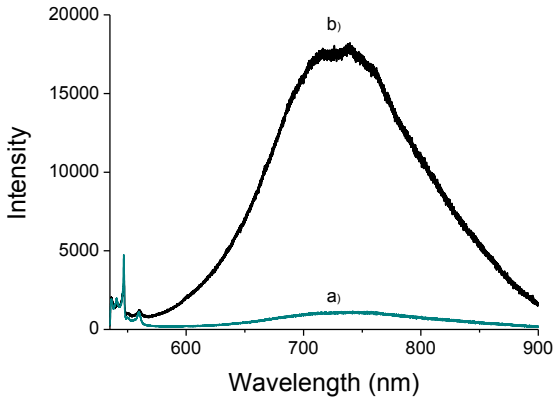

Figure 3. Fluorescence spectra of nanostructured porous silicon: a) loaded with the antitumoral drug emodin, b) loaded with the antitumoral drug emodin adsorbed on silver nanoparticles. Excitation laser wavelength used was 532 nm. All spectra were normalized to the Raman signal from the Si at 547 nm.

Besides optimization of pore size and impregnation conditions of PSi, enhancement factor of fluorescence signal of emodin has been obtained (fig. 3). It varies between 5 and 24 for diverse conditions used. Preliminary Raman and fluorescence studies of other non steroidal anti inflammatory drugs (NSAIDS), in particular ketorolac and indomethacin, in solution and adsorbed on silver nanoparticles will also be presented. Conclusion collected in this study constitutes a first step in the design of a new drug delivery system to be used with emodin or with other drugs like ketorolac or indomethacin.

References

[1] N. J. Halas, Nanomedicine, **4** (2009) 369.

[2] R. J. Martín-Palma, M. Manso-Silván, and V. Torres-Costa, J. Nanophotonics, **4** (2010) 042502.

[3] A. Muñoz-Noval, V. Sánchez-Vaquero, V. Torres-Costa, D. Gallach, V. Ferro-Llanos, J. J. Serrano, M. Manso-Silván, J.P. García-Ruiz, F. del Pozo, and R.J. Martín-Palma, J. Biomedical Optics**, 16** (2011) 025002.

[4] P. Sevilla, F. García-Blanco, J.V. García-Ramos and S. Sánchez-Cortes, Phys. Chem. Chem. Phys., **11** (2009) 8342.

[5] R. De-Llanos, S. Sánchez-Cortés, C. Domingo, J. V. García-Ramos and P. Sevilla, J. Phys. Chem. C, **115** (2011) 12419.