Assessment of the environmental impact on natural resins by a combination of FT-RAMAN and QCM impedance analysis

Andrea Cavicchioli and Dalva L.A. de Faria,
Instituto de Química, University of São Paulo, Brazil

In recent times, an increasing number of researches have targeted the development of analytical systems capable of providing information on the impact of specific environments on the materials of which the objects of the cultural heritage are made[1-2]. Ideally, the conservator ought to be able to collect data both on the type of the chemical changes taking place in such materials during the ageing/degradation processes and on the rate at which these alterations are occurring. Furthermore, it would be desirable to rely on devices providing a response in real time and *in-situ* in order for the analyst to closely monitor the effects of the environments on the materials and be able to promptly adopt quick conservation strategies.

In this context, sensors obtained by modifying quartz resonators (also known as Quartz Crystal Microbalances, QCMs) with thin films of artistic materials (e.g. varnishes) fulfil part of the above mentioned requirements inasmuch as their frequency response is clearly correlated to the extent of the ageing of the material, as it was observed in previous works. In addition, these systems require, to function, only simple, cheap and relatively small equipments[3-4].

The present paper aims to contribute to the establishment of this technology as a tool for indoor monitoring of conservation areas. Electrodeless quartz resonators were coated with mastic and dammar varnish films and their response in terms of frequency and impedance was monitored upon artificial ageing under visible or UV radiation. Impedance spectra, recorded around the resonating frequency, provide information on both changes associated with gravimetric alterations (through the shifts of the curves along the frequency domain) and on the visco-elastic properties of the varnish, (through the modification of the curves' profile)[5]. Electrodeless resonators are particularly interesting for the preliminary characterisation of the sensors since they do not require the thin gold electrode deposited on the quartz disk and, therefore, are much more easily recycled. On the other hand, they impose the use of a specific electrochemical cell and, in this sense, not suitable for field monitoring.

The results obtained with impedance analysis were interpreted in the light of the outcome of the analysis of the varnish films by FT-Raman and FTIR. The coupling of the impedance and the spectroscopic techniques is particularly valuable because they are all non-destructive, with the latter being a powerful tool for the extraction of structural information on the films.

The different behaviour of the two varnish sensors observed by impedance analysis were confirmed by the different rates in the changes of specific band markers identified in the FT-Raman and FTIR spectra, thus validating the use of the impedance (gravimetric) response of the modified resonators to monitor the ageing process. The higher propensity to ageing displayed by mastic *vs* dammar was highlighted in this way. The impedance data showed that visco-elastic changes do take place in the varnish films and, although they are not correlated with the extent of ageing, they are important to qualitatively distinguish different types of alterations, e.g. those induced by visible light (natural) and UV radiation.

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REFERENCES

1. Van den Brink O.F., Eijkel G.B., Bonn J.J., *Thermochimica Acta* **2000**, 365, 1, *and references therein cited.*
2. Costa V., *Museum's air quality in a tropical climate: evaluation by using metallic coupons* **2003,** 5th Meeting of the Indoor Air Pollution Working Group, Norwich.
3. Cavicchioli A., *Chemical Sensors for Indoor Environments* **1996**, MSc Thesis, Birkbeck College, London.
4. Odlyha M., Ormsby B., Pratt K., Slater J.M., Ryhl-Svendsen M., Padfield T., Smith V., Bullock L., de Santis F., Boon J.J., *Continuous Monitoring of Damage Using Piezoelectric Quartz Crystal Based Dosimeters* **2003**, 5th Meeting of the Indoor Air Pollution Working Group, Norwich.
5. Sabot A., Krause S., *Analytical Chemistry* **2002,** 74, 3304.