

Gold and Silver Nanoparticles: from ancient colors to localized surface plasmon resonance sensors

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The *Lycurgus Cup* (4-th Century) is an ancient “Roman nanotechnology” that depicts a mythological scene of the death of King Lycurgus, at the hands of Dionysus and his followers [1]. The glass of the cup is dichroic; in direct light it resembles jade with an opaque greenish-yellow tone, but when light shines through the glass (transmitted light) it turns to a translucent ruby colour. Nowadays, it is demonstrated that the unusual colours result from the presence of metal nanoparticles (gold, silver, or even copper) dispersed in the glass. In Physics, the phenomenon can be interpreted as an interaction between light and metal particles with a size much lower than the wavelength, which originates a collective oscillation of their free electrons, resulting in efficient light extinction (absorption + scattering). This phenomenon is called Localized Surface Plasmon Resonance (LSPR) and it also gives rise to the brightly coloured stained glass windows in medieval cathedrals [2]. The LSPR band can be tuned by the chemical, morphological and structural characteristics (size, shape, distribution, composition, etc.) of the nanoparticles and, in the case of gold, silver or copper, the resonance condition occurs in the visible range, giving rise to a colour palette. Of particular significance is the dependence of the LSPR effect on the refractive index of the surrounding medium. In the length-scale of a few tens of nanometres from its surface, the nanoparticles are sensitive to changes in the environment, being used in several applications as in molecular sensors.

This presentation will begin by addressing ancient decorative applications of gold and silver, and how these plasmonic effects inspired new and "modern" applications. Then, the way plasmonic colours can be obtained using thin film nanomaterials, prepared by a physical vapour deposition technique (magnetron sputtering), will establish the bridge to the development of chemical sensors based on the LSPR phenomenon [3,4]. Finally, future perspectives and emerging applications of plasmonic nanomaterials will be discussed.

Bibliography

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