Available online at www.sciencedirect.com
SCIENCE DIRECT®
Microelectronic Engineering 83 (2006) 597–603
MICROELECTRONIC ENGINEERING
www.elsevier.com/locate/mee

Analysis of works of art down to the nanometric scale

Michel Menu

Centre de Recherche et de Restauration des Musées de France, UMR 171 du CNRS, Palais du Louvre 14, quai François Mitterrand, F.75001 Paris, France

Available online 31 January 2006

Abstract

The material analysis of works of art aims to better understand the techniques of the ancient cultures and to preserve the cultural heritage for future generations. The analysis brings to light new and unique information for authentification, for conservation and more generally in the domain of history of artistic techniques. Until now, the methods were intensively developed and adapted to the specific, precious character of the works of art. Works of art are examined from the macro to the micro down to the nano scale thanks to TEM, atomic force microscopy, ion beam techniques, or synchrotron radiation spectrometries.

Various examples will be developed in order to demonstrate the efficiency of the materials science methods for another entrance door to the cultural heritage artefacts.

PACS: 82.80 Yc; 81.70 Jb; 81.07 Bc

Keywords: Conservation science; Works of art analysis; Ion beam analysis; TEM

1. Introduction

The analysis of works of art brings to light new and unique information for authentification, for conservation and more generally in the domain of history of artistic techniques.

Not so long ago, nobody was astonished at all by an association between art and science. During the Renaissance, for instance, the artists were also the scientists, they were as well engineers, architects, painters, etc. *Ars* and *Technè* were the same word, one in Latin, the other in Greek.

Today, the situation is more complex, and the connexion between art and science is a problem. Science, as it is understood today became a specific discipline during the 17th century. On the other hand, art became autonomous during the 19th century, mainly due to the Romantic behaviour of the lonesome artist. There is undoubtedly part of nostalgia for a past during which the two disciplines should have been combined by brilliant people. Today, art and science are more or less incompatible, and cannot be approached simultaneously, in the same way, with the same instruments. One can testify to desperate efforts for an illusory reconciliation between the scientific practices and the artistic ones. Following the physicist and philosopher Jean-Marc Levy-Leblond [1], one is sceptical in front of the "fairly frequent attempts to connect art and science, because truth should not be kept by the second discipline and beauty by the first one. How many eminent scientists enjoyed the splendour of an equation, beauty becoming part of the proof! On the other hand, science involves some artistic expressions, but only a pale and naïve illustration of a scientific experience." For Jean-Marc Levy-Leblond, art and science may join together only for short encounters, where the techniques should also be associated. Among those, the engagement of laboratories for rediscovering the various knowhow of the artists, and the technical invention of the ancient cultures, proves it is possible.

The material analysis of works of art aims to better understand the techniques of the ancient cultures and to preserve the cultural heritage for future generations.

E-mail address: michel.menu@culture.fr.

0167-9317/$ - see front matter © 2006 Elsevier B.V. All rights reserved.
doi:10.1016/j.mee.2005.12.020

From the 1960's, the examination, characterisation, analysis (elemental, structural, textural) of the museum and archaeological artefacts followed closely the progress of Materials Science. Rapidly, investigations were undertaken at the micrometric range using the scanning electron microscope. For example, in the study of paintings, pigments were identified thanks to the analysis of their chemistry and texture, at the same time, the various compounds used with pigments were characterised: extenders and binders, the latter involving organic analysis.

The methods were intensively developed and adapted to the specific, precious character of the works of art. Works of art are examined from the macro to the micro down to the nano scale thanks to TEM, atomic force microscopy, ion beam techniques, or synchrotron radiation spectrometries.

Today, the tracks registered in the matter may be identified down to the nanometric scale. These tracks, registration of the physical or chemical changes inside the matter, may be interpreted as:

Origin of the materials for the rediscovery of the ancient trade routes,
Transformation of matter for the knowledge of the various knowhow of artists and craftsmen.

So, today, Conservation Science is really a scientific discipline, combining equally, history of art and materials science. To give an overview on "Conservation Science", several examples will highlight the complementarities of the various analytical methods and the necessity of bringing together various scientific competences.

1.1. Otto Marseus Van Schrieck and the representation of Nature in paintings during the 17th century

Otto Marseus Van Schrieck was a Dutch painter who became famous for his invention of "Sottobosco". These still lives represent a wild Nature filled with snakes, batrachians, lizards and insects. Born in Nimegen, Nederland, in 1619 or 1620, he was nicknamed by his colleagues the "snufellaer" (the ferret) during his stay in Italy, because of his curiosity for the strangeness of nature. Marseus' invention, known today as the "Nature Piece", offers the first sustained pictorial account of reptiles and insects in the history of European painting. Back from Italy in 1655, he settled, until his death in 1678, near Amsterdam where he collected living specimens gathered during excursions into the countryside.

The examination of the painting kept in the Museum of Fine Arts of Grenoble, France, brings to light the innovative technologies employed by the artist. *Butterflies, snake and thistle* (61 cm high by 50.5 cm large) is an unsigned painting attributed to Otto Marseus Van Schrieck (Fig. 1).

He designed an idealised habitat, modelled on biological dioramas, which are illustrations with a three-dimensional effect. The thistle is the main element of the composition,

Fig. 1. Otto Marseus Van Schrieck: *butterflies, snake and thistle* (Musée de Grenoble) infrared photography.

with a long thorny stem crowned by a closed flower, surrounded by a bunch of spiralled leaves. The plant is an acanthus thistle, precisely depicted. The "Dutch art (of the 17th century) is a meticulous description of the universe, executed with an extraordinary know-how" (Svetlana Albers, *The art of describing,* 1983). Three butterflies are flying through the thistle leaves. The central one can be recognised, as a peacock butterfly with a scientific name *Inachis io*. The two other are not well preserved and cannot be easily identified. On the left side of the painting, a snake is hunting the insects.

In 1987, the German conservator, Bodo Beier published in *Maltechnik Restauro* his results of his observations after the restoration of an 18th century "still life" painted by the German Johann Falch. Beier mentioned that the butterfly were not painted but realised thanks to a specific technique of transferring the wing scales on a prepared substrate. Beier named this method a "contre épreuve" and showed that this technique was used earlier in paintings of Marseus van Schrieck [2].

Nevertheless we were able to describe more precisely the technique achieved by the Dutch painter thanks to a careful observation undertaken with the valuable help of Serge Berthier, physicist and entomologist. It is not an impression of the butterfly wings as it was done by Picasso or Dubuffet during the 20th century. The scales were transferred on the paint following a specific method developed by the entomologists, especially during the 19th century. The first explanations may be found in the French literature in 1771. Marseus Van Schrieck is a fore-