

SPECTROSCOPIC DATING AND CLASSIFICATION OF WOOD

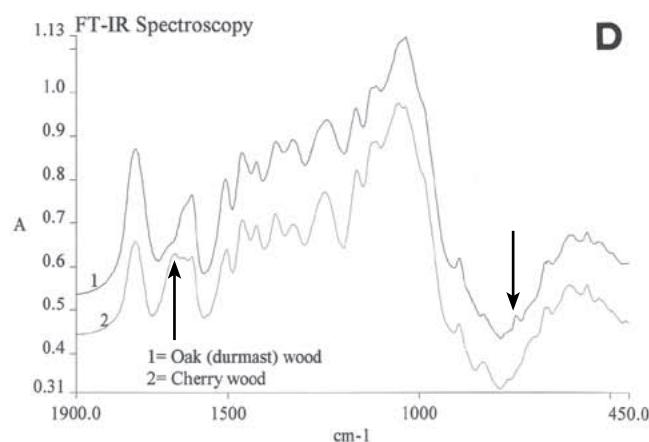
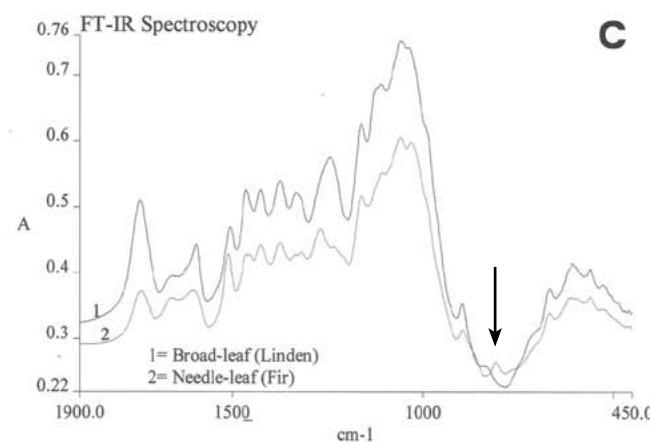
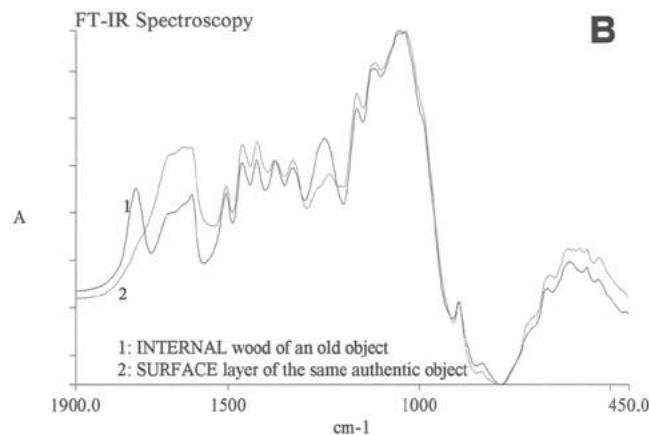
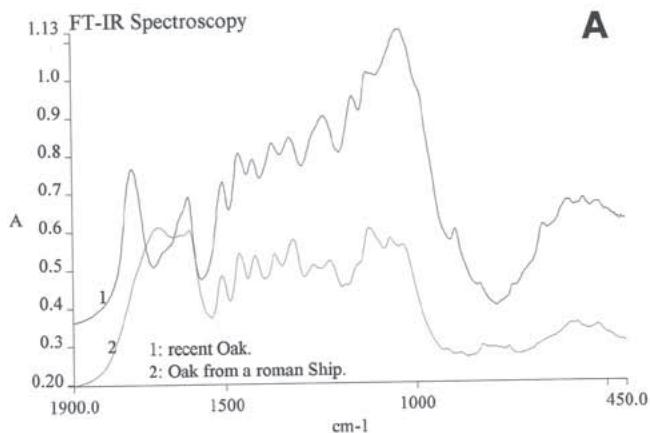
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INTRODUCTION

IR spectroscopy is used on a vast scale in industry and research for chemical analyses. The novelty lies in its use for measuring the age of wood. The molecules present in wood absorb the IR rays emitted by the spectrophotometer if they oscillate at the same frequency. The spectrum showing this absorption, with its peaks and valleys, is like a fingerprint of the substance under examination. Change undergone by a molecule or group of molecules, owing for example to aging, is shown up by a displacement of the frequencies and by an alteration in the absorption intensities. The age of the wood is established by comparing these changes to spectra of certain dating.

The following problems and considerations had to be taken into account at the beginning of the research:

1. Various tree types have different chemical compositions and aging times. It is well known that faster-growing wood perishes more quickly. We also know, for instance, that pine is richer in resin than birch and that there are three main types of oak found only in Europe. Identifying these types of woods, finding objects of different ages made from them and confirming the presumed age of these objects for the creation of reference tables for spectroscopic dating has taken eight years. This research was carried out primarily in our laboratory, in collaboration with international organizations and museums.
2. A dating method based on chemical decay must consider the fact that temperature and humidity may accelerate the process. This factor of uncertainty makes it necessary to know the history of the conservation of the object because of the possibility of artificial treatments influencing the results of the measurement, and this was taken into consideration in the compilation of the spectroscopic dating tables. However, most wood molecules have an ageing process which is not influenced by temperature and humidity as demonstrated by excavated wooden objects, as well as amber, a fossilized resin which has remained under the sea and in riverbeds for millions of years. Graph A shows two spectra. Curve #1 is that of fresh oak and curve #2 is of oak from a Roman ship buried for 2,000 years under wet soil. The spectrum of the ship is still typical of the wood. Amongst these molecules are those which are used for spectroscopic dating. Extensive international studies have always confirmed the extreme resistance of wood to heat and water. In our laboratory we tested a piece of maple and a piece of pine in continuous cycles of varying temperature and humidity for two years. No measurable differences of the frequencies used for dating were observed.
3. It is important to be able to detect the use of old wood for recently-made fakes. Otherwise, no wood-dating method can be considered as definitive. The surface layer of any wooden artefact has undergone chemical changes due to UV light and other environmental agents. Since spectroscopy is a chemical analysis, it can detect these differences. Graph B shows the difference in wood from the same 300-year-old object between the surface (curve #2) and its inner part (curve #1). If an object is made of wood that is already old, both curves are nearly identical.



GRAPHS A, B, C & D

4. As frequencies and absorption intensities used for dating may differ according to the many families or types of trees, it is necessary to recognize the tree type under examination simply and quickly. Spectroscopic analysis offers this possibility. The curves of Graphs C and D illustrate this. The first test in the dating of wood is dedicated to the important distinction between needle-leaf and broad-leaf trees. The peak of Graph C, indicated by an arrow, represents the substance known as "coniferous alcohol" present in all coniferous trees examined so far. In Graph D the arrows indicate a peak formation typical of oak and cherry. Observation of a single peak or a combination of special peaks has allowed us to identify at least the tree family in approximately 90% of tests carried out to date.

5. Trees from tropical areas require special tables, but since tropical trees are subject to a similar chemical decay as trees in Europe or

North America, the compilation of specific tables was only a question of additional research work. We already have at our disposal data with a precision of ± 10 years or less for most woods used in African sculpture and approximately ± 25 years for carvings from Southeast Asia.

6. The method may be rejected, because it is seen as "destructive." However, the damage to the object created by the taking of wood samples is very limited compared to the severe damage the wood material may have suffered in the past centuries.

The following five photos show how a sample is taken.

Figure 1: A small hole 2 mm wide is drilled into a sound part of the wooden object. The wood-powder obtained from the first millimeter can serve to discover the use of old wood. From an approximate depth of 3 mm onward for about another 3 to 5 mm the wood-powder is collected for the age test.



FIGURE 1

Figure 2: The wood particles are checked for impurities such as woodworm contamination, which could create errors.

Figure 3: After a stabilizing treatment, pressed particles are mixed with a transparent substance into discs.

Figure 4: The transparency of the disc demonstrates the tiny amount of wood required.

Figure 5: The disc is inserted into the spectrometer and then the spectrum is printed.

The following disadvantages and problems presented by the method are as yet unsolved:

- Some woods like mahogany, rosewood and chestnut are not yet datable with accuracy.
- Objects which have remained for long periods below freezing point, yield results that appear younger than the actual age because the chemical processes in the wood have been slowed. We have this problem in Europe with beams from ruins of old castles and churches in the mountains.



FIGURE 2

- Accuracy diminishes with time. The margin of error, which is around ± 10 years up to about 350–450 years of age increases to about ± 50 years for woods of 800 years or more.
- Trees from the same family may have developed subtypes in other continents. In order to elaborate a complete dating table for new subtypes, two samples of certain dating are required.

The following are some advantages of this method:

- The dating method has reached a high degree of reliability. It is simple, quick and cheap.
- In addition to age, spectroscopic analysis also provides information about the type of wood tested.
- Only the method based on spectroscopic analysis permits detection of the use of old wood in a newer object.
- Dating accuracy is bound to improve as more samples of certain date become available.
- Comparison of spectroscopic datings—which are largely independent of the place where the

tree grew or the position of the wood in large trunks—with the results of existing dating methods will reduce margins of error.

- Spectroscopic analysis is used in other fields of antique art objects. The method is gaining importance for its quick and precise classification of lacquers, glues and pigments, as well as encrustations on iron, bronze and excavated ceramics by comparing traces of such samples with existing dependable spectroscopic absorption spectra.

SPECIFIC APPLICATIONS FOR ART MUSEUMS

All museums have big problems with their inventories, in which a high percentage of furniture, wood statues and painted panels are waiting to receive a precise and definitive classification. Spectroscopy can therefore be of service in the first place to museums for their internal use.

FOR MORE INFORMATION

- www.museodelcollezionista.com
- www.SpectroscopyforArt.com

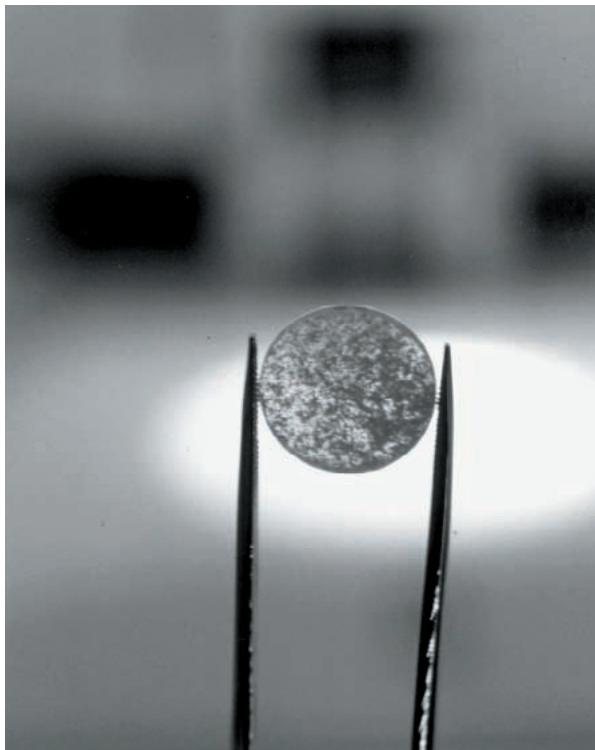


FIGURE 4

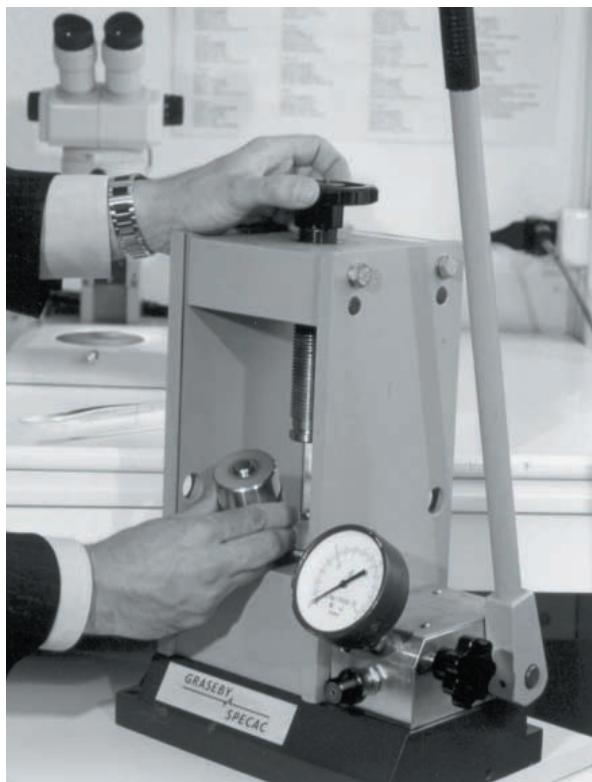


FIGURE 3



FIGURE 5