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Wood treatments in historical bowed string instruments from Cremona (Italy)

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***Abstract* – Six fragments obtained from historical instruments produced in Cremona (Italy) during the 17th and 18th century have been considered. Both non-invasive and micro-invasive instrumental techniques were carried on to directly highlight the treatments employed on the wood before varnishing. Scanning Electron Microscopy performed on cross sections highlights the presence of two different methods of wood treatment, in order to inhibit the penetration of the varnish into the porous structures. In one set of fragments, the wood was treated with a filler made with gypsum dispersed in an organic medium. A mechanical treatment or a digestion of the wood structures with a basic solution, which caused a collapse of superficial tracheary elements, was employed on the other fragments.**

Keywords: Bowed musical instruments, varnishes, wood fillers, wood treatments, Scanning Electron Microscopy.

I. INTRODUCTION

Some among the most famous bowed stringed musical instruments ever built in the world have been produced in Cremona (Italy).

The most outstanding violin-makers - among whom Antonio Stradivari is the most celebrated - were active during the 17th and 18th centuries, a period known as the "golden age" of Cremonese art of making stringed instruments. However, few documents have been left about methods of the ancient violin makers, therefore most of their know-how have been lost through the centuries. Among the large set of materials, fillers and varnishes seem to play a pivotal role in determining both aesthetic properties and acoustic performances. Nevertheless, the large variety of materials which can be found in written documents - and their countless combinations in particular [1] - push the interest towards direct testing of the instruments by physical and chemical instrumental analysis. Normally, only non-invasive analytical approaches are feasible for the investigation.

Systematic scientific investigations on the instruments are scarce, and mainly focused on Stradivari [2]. Moreover, the widest attention has been given to the outer (and most accessible) finishing layers. The varnish can in fact be investigated by non-invasive spectroscopic techniques [3]. Less attention was instead dedicated to wood treatments under the varnishing layers, although wood preparation may also play a crucial role in the study of diversities and similarities among workshops.

Wood preparation can be investigated throughout when samples are detached from the musical instrument, which is rarely the case when famous and extremely highly prized instruments are considered. This work deals with six fragments obtained from historical instruments produced in Cremona during the 17th and 18th centuries by a set of relevant Cremonese violin makers. Samples were taken from them and therefore these fragments offered us a unique opportunity of investigating the layers on the wooden surface by both non-invasive and micro-invasive instrumental analytical techniques.

With more details, the fragments were removed during past restorations from the following instruments:

- one viol attributed to Nicola Amati (A);
- two cellos attributed to Jacob Stainer (B,C);
- one cello attributed to Francesco Ruggeri, known as "il Per" (D):
- one cello attributed to Andrea Guarneri (E);
- one double-bass attributed to Lorenzo I Guadagnini (F).

The fragments are shown in Figure 1. They are associated to capital letters as in the above-reported list.

The focus of the present scientific investigation is the elucidation of materials and methods that were employed to seal the porosity of the wood, in order to prevent the penetration into the pores of the wooden substrate of the varnishes applied upon it.

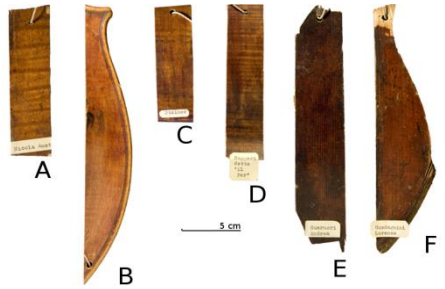

Fig. 1: Overview of the investigated fragments. Capital letters as reported in the text.

The aim of the work is to enlarge our knowledge on methods and materials employed during the "golden age" of the Cremonese production, and to obtain preliminary data for highlighting whether a same treatment was shared among workshops, or if specific treatments can be linked to specific violin makers.

II. EXPERIMENTAL

A small chip was detached from each of the six fragments preserving the original stratigraphy.

Samples were embedded into epoxy-resin and then abraded and polished in order to expose their cross sections to the analytical beam. These were imaged by optical microscopy - under visible and UV illumination - and investigated by scanning electron microscopy coupled with microanalysis (SEM-EDX).

III. RESULTS

Besides a general variability in the stratigraphy of the cross sections, two main approaches were highlighted for wood treatments (Figure 2).

In three samples, namely the cellos from Stainer (B,C) Ruggeri (D) and Guarneri (E), an organic preparation layer is visible under the varnish (Figure 2). Signals of calcium (and sulphur) detected by SEM-EDX from some of the particles dispersed in the organic matrix may suggest the presence of gypsum.

A different situation was detected for the viol by Amati (A) and the double bass by Guadagnini (F). Here, no distinct layer was present for sealing the wood porosity (Figure 2). Nevertheless, the structure of the wood at the wood-varnish interface appears heavily modified. The wood porosity seems to be sealed here by the collapse of the tracheary elements within about 20 µm on the surface of the wood.

This effect can be obtained by pressing the wood surface with a metallic tool like a wood scraper. Alternatively, it could have been obtained by treating the wood with a basic solution, which digests the superficial layer of the wood structures. Intense signals of potassium, detected by EDX at the wood-varnish interface may possibly represent a trace of a treatment with wood ash (rich in potassium carbonate), which was a common material suitable to be employed to this aim.

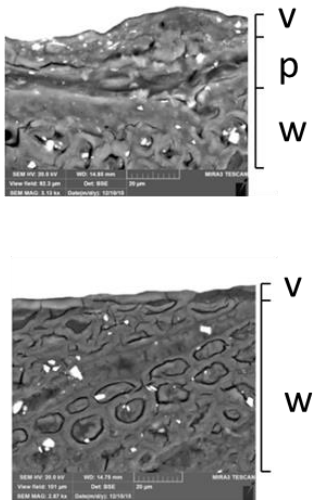

Fig.2: SEM images characteristic of the two methods of wood preparation highlighted within the investigated fragments. Varnish (v), preparation layer (p) and wood (w) are highlighted.

IV. CONCLUSION

The strategy employed by three coheval Italian masters (Stainer, Ruggeri and Guarneri) to seal the wood porosity may indicate the sharing of common procedures among Cremonese violin makers during the second half of 17th century. On the other hand, the fact that the fragments attributed to Nicola Amati and Lorenzo I Guadagnini showed the same treatment is more complex to explain. A wider analytical frame on the Cremonese production, which is presently lacking, may possibly enable the interpretation of this point in the future.

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