STUDY OF SURFACE AND RESISTANCE CHARACTERISTICS OF SPECIAL WOOD PRODUCTS COVERED OF ECOLOGICAL COATINGS

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Abstract

The article engages in research into of relation varnish - wood (plate) and acoustic characteristics of final product – violin. The work deals with the quality evaluation of surface finishing and indicates the possibilities for the surface finishing assessment of the string musical instruments. The new method – electronic speckle pattern interferometry (ESPI) was used for the study of the influence of surface finishing on the physical and acoustic characteristics of wood and acoustic quality of violin.

Key words: acoustics quality, wood, elasticity, surface finishing , ESPI method

INTRODUCTION

At present, utilization of wood is predetermined by its unique properties of the natural material. It has an indispensable place in construction of musical instruments [1], where the influence of tradition plays an important role in material selection. The properties of wood and surface finishing significantly influence on the tonal quality of final instruments, especially violin. Therefore the properties draw attention of not only the tradesmen, musicians and listeners of music but also scientists. The effective valuation of material means that a product made of it is highly evaluated.

THEORETICAL STARTING POINTS

The shape complexity and anisotropy of wood influence the shapes of the vibration of free violin plates. The resonance frequencies of the 1st, 2nd and 3rd modes are used at the calculations of elastic characteristics.

The formulae for calculation of modules of elasticity E_x and E_y in a free violin plates are given: [3]

$$E_X = 12\eta D_1, \quad D_1 \approx \frac{f_5^{\,2}\rho a^4}{h^2} \quad \text{and}$$

$$E_Y = 12\eta D_3, \quad D_3 \approx \frac{f_2^{\,2}\rho b^4}{h^2}$$

where $\eta = 1 - \mu_{xy}\mu_{yx}$ and μ is Poisson constant.

EXPERIMENTS

The equipment REZONATOR (Fig. 1) was designed at the Department of Physics, Electrical Engineering and Applied Mechanics.

Fig. 1 REZONATOR

The measured plates were horizontally placed on the plastic foam. The plates were excited by loudspeaker placed under the plate. The signal is transmitted to loudspeaker by amplifier from the tone generator. By means of the tone generator were searched the resonance frequencies plates and their changes influence of surface finishing (Fig. 2).

The experimental plates were used to making experimental violins and their vibrating patterns and tonal quality were observed before and after surface finishing.

The oil-based varnish (natural resin - sandarak, mastic, manila-elemi and natural color - Dragon's blood (Resina Draconis)) [4] was used on the surface finishing of the parts of experimental violins. After applying and drying of varnish were carefully re-measured resonant frequencies as well as pitch of violin parts (plates).

Several of surface finishing plates were used to evaluate resistance of surface finishing against acting of cold liquids (test 1 of experiment) and from other ones was made experimental violin.

The results of test 1 are given in tab 1. (6 hours of exposure of cold liquids). When compared to

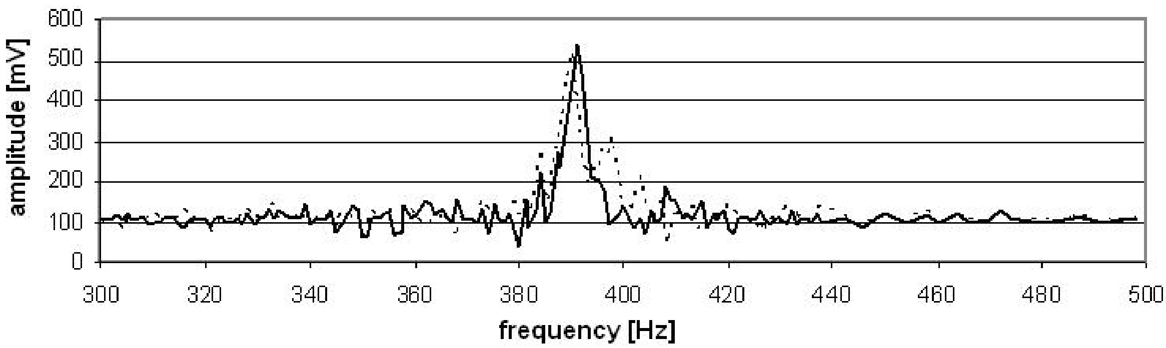

Fig. 2 Frequency response of one plate before and after surface finishing

standard for surface finishing of furniture, where the maximum tolerance level of damage to furniture is 4 for A, B, the marked fluid has not complied with. After this test, it can be concluded that the varnish on musical instruments are sensitive to external influences (action-cold liquid chemicals, foodstuffs).

Tab. 1 Results of resistance evaluation towards some cold liquid

Liquid	Oil basis varnish
Red wine	5
Sodium chloride (15%)	4
Spittle	4
Ammonia (10%)	4
Distilled water	5

Electronic speckle interferometry

The pulsed ESPI technique allows recording two different states of a vibrating object with very short time intervals and comparing these states quantitatively. In order to do so, the object under investigation is illuminated twice by the very short light pulses of a pulsed laser.

A high speed camera records the two images of the laser illuminated object and stores them on a computer. From these two images the quantitative displacements of each object point in the field of view is automatically calculated in few seconds (Fig.3).

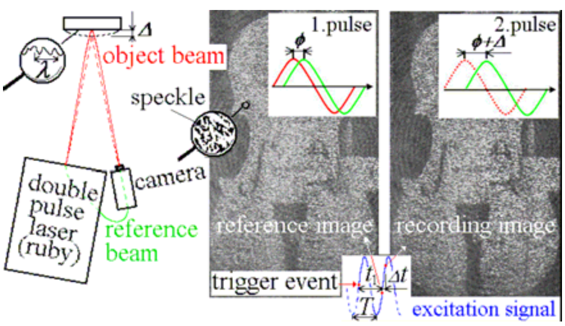

Fig. 3 Schematic presentation of principle of the ESPI visualization: [5]

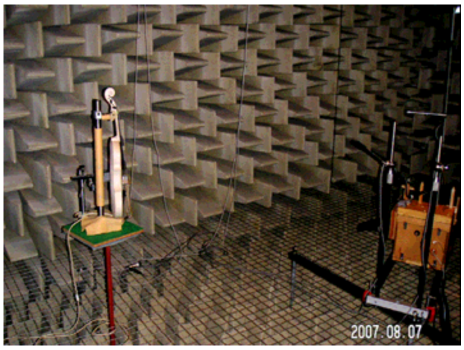

Fig. 4 Measurement of frequency transfer function

The far field frequency transfer function of the violin was measured in anechoic room. The violin was artificially driven by the Dünnwald exciter (Fig.4) powered by frequency generator (from 0.1 to 2.4 kHz).

From the obtained curve the resonance peeks were chosen. The violin body vibration patterns, at some of these resonance frequencies, were observed by the electronic speckle interferometer (Fig.5). The patterns were compared and the connection between the vibration pattern and the shape of the frequency response was discussed.

CONCLUSIONS

The ESPI visualization [2] of the violin vibration is very useful method for the investigation of surface finishing influence on the string musical instruments. This method helps us at investigation of influence of wood quality on the tonal quality of completed violin.

We can see that above 1 kHz is open own resonance of small parts of violin (tailpiece, chin rest, free end of fingerboard) and maxima in vibration patterns are concentrated. Round 2 kHz also is open the bridge own resonance.

The symmetry of the vibration patterns and the directivity of violin radiation above 1 kHz play a significant role and low level in certain direction could not occur in other direction (e.g. level and pattern at 1.45 kHz).

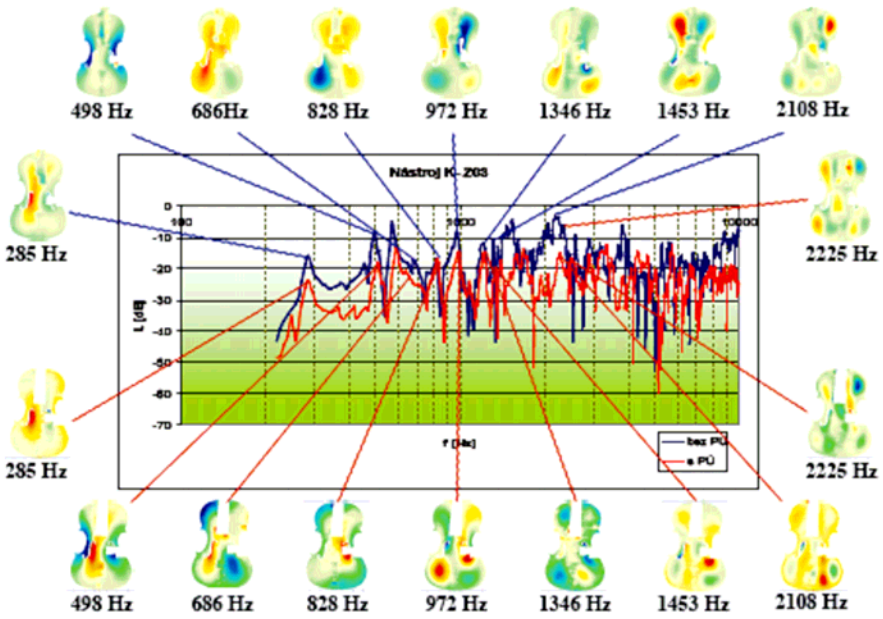

Fig. 5 Violin body vibration pattern at particular frequencies: [4]

From Fig. 5 is evident that the surface finishing influence on tonal quality of violin.

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