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Possibilities of using the thermally modified wood in the electric string instruments

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Abstract: *Possibilities of using the thermally modified wood in the electric string instruments*. This paper consider the possibilities of using thermally modified wood in electric string instruments. Physical, acoustic and aesthetics parameter but also affects to sound timbre are considered. The biggest advantages of modifying wood is lower mass and its aesthetical values. Wood modification gives also sound timbre changes, but they varying a lot for each frequency.
Keywords: wood, thermo wood, electric guitar, sound timbre

INTRODUCTION

Thermal modification of wood has become a very popular topic. It's willingly used due to its dimension stability increasing (even 50%) and aesthetic tropical-like wood values (Boonstra et al 1998, Nakao et al. 1983, Fengel and Wegener 1984, Bhuiyan et al. 2000). Those two parameters changes can be positively used in electric string instruments (e.g. electric guitars/basses). Higher dimension stability can gives greater tuning stability, what means instruments will need to tune less. Making bright wood to a tropical-like, dark one can positively effect to its look and finally, price.

All of those changes are results of chemical changes in wood. Except stability and colour changes, modification effects density and modulus of elasticity (MOE)(Hanger et al. 2002, Ding et al. 2011, Windeisen et al. 2009, Esteves et al. 2007, González-Peña and Hale 2007, Boonstra 2008). Those two parameters are mainly responsible for acoustic properties of wood, e.g. sound propagation velocity, acoustic resistance, damping of sound radiation, acoustic constant (Ono and Norimoto 1984 Rajcan 1998, Barlow 1997, Meyer 1995, Kollmann and Cote 1969). Greater MOE with relatively lower density gives higher specific MOE, one of more important parameter of resonant wood. But in electric string instruments with solid body, influence of resonant properties of wood are unknown. However, lower density gives lower weight of solid body instruments, which is big advantage.

Thermal modification also gives disadvantages. Wood after modification is more fragile (González-Peña and Hale 2007, Boonstra 2008). Badly-proceed process gives cracks both during and after the process. Modification process cost money, and often in practice it`s hard load all industrial chambers with one species. And we need it to set correct parameters of modification.

The main aim of study is to check how modification effects to electric sound timbre. Changes of MOE, density and related with it acoustic properties of wood are also considered.

METHOD

Four air-dried, unedged lumber were chosen from "Stefan" sawmill (Włoszakowice, Poland). Each lumber with 1,6 m long were cut for two equal pieces to length. One of them was thermally modified. From each pair received modified and not modified plank. Because they were cut from one lumber, their properties were similar. Not modified plank was taken as a control. Finally, after handling and seasoning four (laboratory conditions: 38 ± 2 relative humidity, 17,2 +/- 1 ^{O}C temperature) pair of modified and control planks with dimension 700x70x16 mm were made. From each plank, by adding tuner, bridge and string models were made (figure 1b). String scale length is similar to that in electric guitars.

To put the string to vibrate guitar pick was use. Pick was mounted on pendulum which gives constant energy of impact. Sound was recorded at the same time with pickup and microphone(figure 1a): electromagnetic, active pickup type humbucker: Bartolini E 94-D Active, powered by 9 V battery and GARS 40 AN microphone with SVAN SV 08A preamplifier. Signal was recorded via USB interface Saffire PRO 26 on the Cubase program. All recordings were carried out in an anechoic chamber in Adam Mickiewicz University in Poznan. On each model five different string were recorded: E6 – B2 which gives 83-247 Hz range. Each configuration was recorded fivefold. After all, recorded sound samples were analysed on Artemis software. Psycho-acoustic (sound timbre) parameters: roughness [asper], sharpness [acum] and loudness [sone] were analysed.

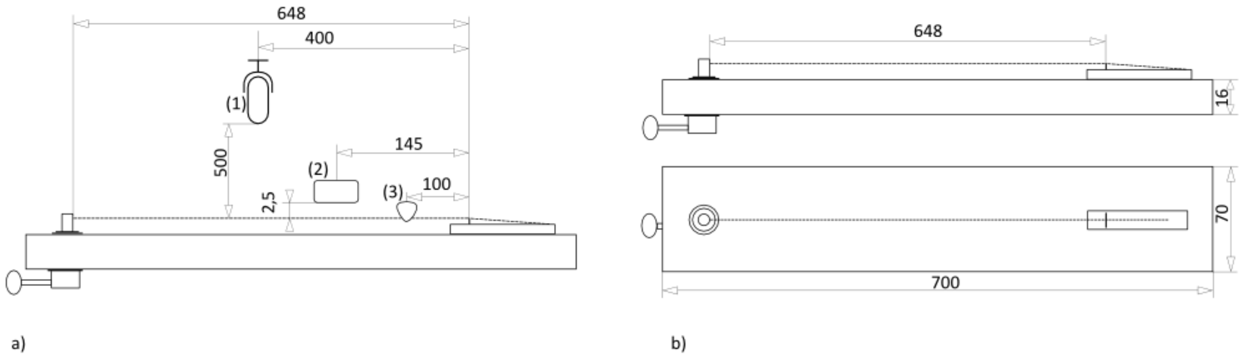

Figure 1. Models (b) and recording (a) scheme.

RESULTS AND DISCUSSION

According to the literature, thermal modification gives similar results (table 1). Except sample number 3, density decrease range from 6,5 to 6,8%. The reason that sample 3 different so much can be explained by the biggest diversity between macrostructure of control and modifying sample.

Sound velocity increase (7 to 11%) witch gives higher dynamic MOE. Lower density with higher MOE (Figure 2) gives higher specific MOE. That means positive impact on most of the acoustic properties of wood. However, it’s hard to say how acoustic properties of wood will affect the sound of solid body, electing string instruments.

Table 1. Comparing density, MOE, specific MOE and speed of sound propagation changes in ash wood before and after modification

Parameter	No.	Control ash	Modifying ash	Increase/decrease [%]
Density [kg/m^3]	1	689	642	-6,8
	2	691	644	-6,8
	3	559	542	-3,0
	4	541	506	-6,5
Dynamic MOE [MPa]	1	15410	17704	+14,9
	2	15155	16172	+6,7
	3	11902	13872	+16,6
	4	11648	12551	+7,8
Sound velocity L [m/s]	1	4730	5251	+11,0
	2	4682	5012	+7,0
	3	4616	5058	+9,6
	4	4638	4981	+7,4

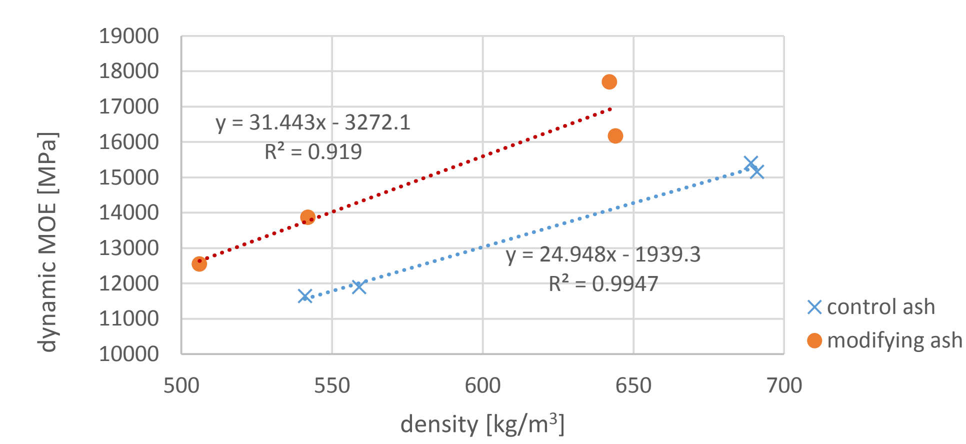

Figure 2. Correlation between dynamic MOE and density for control and modifying ash wood.

Result of the psycho-acoustic parameters on Artemis software didn`t show any clear results. Values of roughness, sharpness and loudness varies differently between control and modifying samples for each frequency (string). Also no clear correlation between microphone and pickup was found. Only roughness and sharpness for microphone recorded samples (figure 3) show something interesting. After modification roughness and sharpness for each frequency (string) is changing more evenly. In practice, it can gives more balanced instrument sound of each string (and maybe in each fret position).

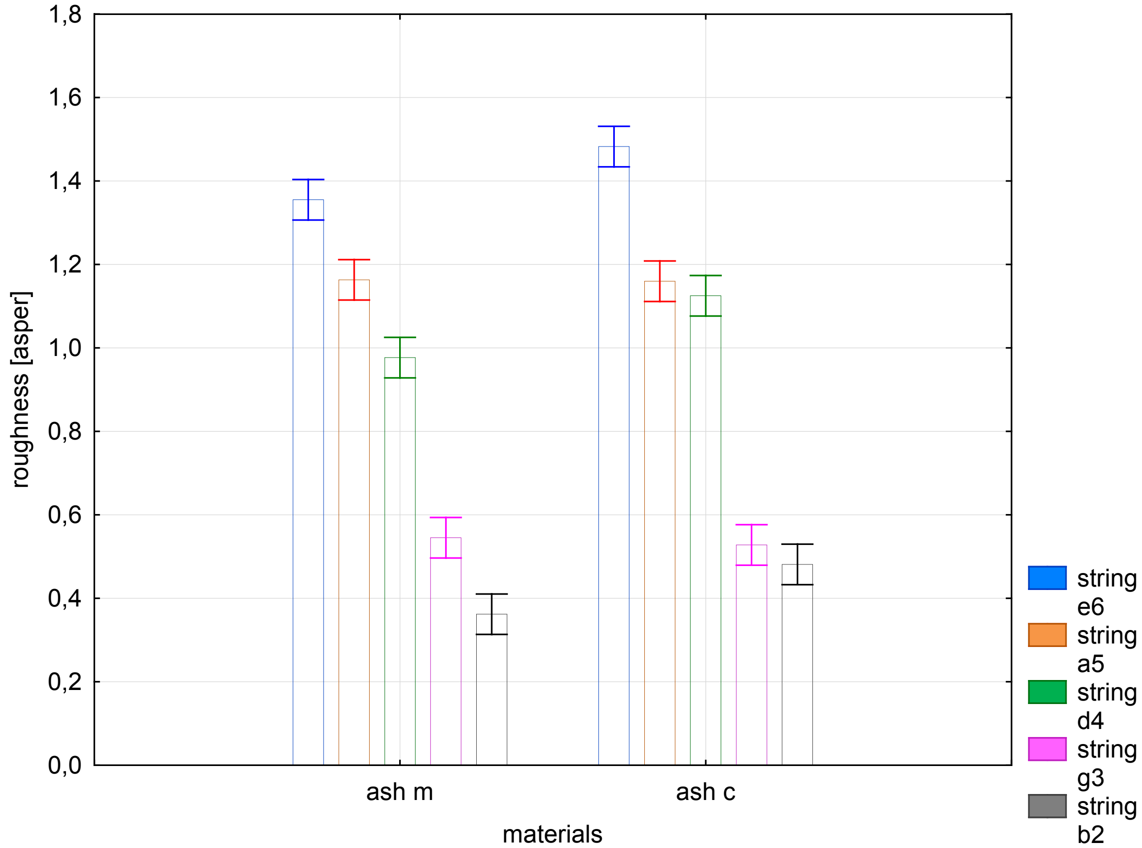

Figure 3. Correlation between used materials and rougness [asper] for five strings. Signal recorded via microphone.

CONCLUSIONS

On the grounds of the results, it can be concluded that:

1. Thermal modification decrease density, which gives lower instrument weight. Among colour changes, that's the clearest and most significant advantages.
2. After modification acoustic properties of wood are positively changed. However there are no clear correlation between those parameters and sound timbre.
3. Modification gives some sound timbre changes, but those changes varies a lot in each frequency (string). In some cases modification provides more balanced sound timbre but only from resonant wood (microphone recording, no effect on the pickup).

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Streszczenie: *Możliwości wykorzystania drewna modyfikowanego termicznie do budowy strunowych, elektrycznych instrumentów muzycznych*. W pracy rozważono możliwość wykorzystania drewna modyfikowanego termicznie do budowy strunowych, elektrycznych instrumentów muzycznych. Analizie podlegały fizyczne, akustyczne oraz estetyczne parametry materiałów a także wpływ modyfikacji na brzmienie tej grupy instrumentów. Największą zaletą modyfikowanego drewna w tym zastosowaniu jest niska waga oraz jego walory estetyczne. Modyfikacja powoduje pewne zmiany barwy dźwięku, jednak różnią się ona znacznie dla poszczególnych częstotliwości.

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