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Volume 355

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Mehran Roohnia

# Properties and Treatment of Tonewood for String Instrument Construction

A Professional Guide

Mehran Roohnia   
Turkish Handcraft Arts Association  
Konya, Türkiye

ISSN 0933-033X ISSN 2196-2812 (electronic)  
Springer Series in Materials Science  
ISBN 978-3-032-00823-7 ISBN 978-3-032-00824-4 (eBook)  
<https://doi.org/10.1007/978-3-032-00824-4>

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*To my kind wife Negin and my cute daughter  
Rojina*

# Foreword

As three professional luthiers with diverse specializations—historical Persian instruments, classical and flamenco guitars, and violins—we reflect the broader community of artisans who have benefited from the author’s instruction. For generations, craftsmen like ourselves have transformed wood into instruments that resonate with musicality. This journey has consistently presented challenges related to the selection, treatment, tuning, and preservation of suitable timber. For those of us whose expertise is rooted more deeply in workshop experience than in academic curricula, access to practical, scientifically grounded knowledge has been consistently difficult. This context underscores the exceptional importance of the present volume.

Dr. Mehran Roohnia’s *Properties and Treatment of Tonewood for String Instrument Construction—A Professional Guide* is more than a technical reference for researchers; it is a foundational bridge between academic science and the applied art of instrument construction. This book effectively translates complex scientific principles into an accessible and practical guide for luthiers, without sacrificing scientific rigor.

We have each had the distinct privilege of receiving direct instruction, both theoretical and practical, from Dr. Roohnia. His research and teaching have fundamentally influenced our methodologies for wood selection and preparation. From the precise acoustic characterization of wood samples using sophisticated instrumentation—including tools we learned to construct ourselves—to the understanding of orthotropic wood properties, spectral analysis via FFT, and the precise tuning of resonances, these concepts have advanced our practices from purely empirical approaches to optimized, scientifically informed methods. A significant proportion of our current technical decisions regarding wood selection are directly informed by the principles taught by Dr. Roohnia, principles that, until now, were primarily accessible to us within the Middle Eastern instrument-making community and are now, through this publication, available to luthiers worldwide.

The distinction of this book lies not only in its scientific content but also in its remarkable clarity and directness. Many academic texts in this domain are often couched in language that is challenging for empirically trained luthiers. In contrast, this work maintains its scientific precision while adopting a language accessible

and relevant to all instrument makers, irrespective of their background. It is a rare achievement to present such profound subject matter with such clarity, engaging both intellectual understanding and practical application. Furthermore, the author's consistent responsiveness to questions from luthiers via email, LinkedIn, and other platforms is truly exceptional.

- My professional life, as Siamak Ghalami (the main author of this foreword), has been dedicated to the hereditary tradition of reviving and constructing ancient Persian instruments such as the Ghaychak and Robab. The insights within this book have enabled me to integrate rigorous scientific methodology with established ancient traditions, thereby advancing the international recognition of these historical instruments.
- Ramin Fallah, the second contributor to this foreword, is renowned for crafting professional classical and flamenco guitars that have achieved significant acclaim among musicians in our region and across Europe and North America. The exceptional acoustic precision of his instruments is largely attributable to the precise criteria for wood selection, treatment, and adjustment detailed in this publication.
- Mikaeil Ghazal, the youngest co-author of this foreword, has, even in his third decade of life, established himself as a respected figure in violin making. This rapid ascent is due to his early and consistent integration of these scientific teachings with practical workshop methodologies.

Based on our collective experience, we unreservedly recommend this book to all luthiers globally, whether their focus is violins, guitars, or other traditional string instruments. If you have previously perceived a disconnection between scientific principles and practical application in the selection of wood for musical instruments, this book effectively bridges that gap. For those already incorporating acoustic or engineering principles, this volume will undoubtedly augment your existing analytical toolkit.

We consider it an honor to have studied under the esteemed author and are proud to contribute this foreword in recognition of a work that is poised to significantly shape the future of wood science and the art of instrument making.

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# Preface

Wood has resonated with humanity for millennia. Long before the age of steel, silicon, and synthetic polymers, humans shaped nature's most organic offering—wood—into tools of expression. Among these tools, musical instruments have held a particularly sacred place. The warmth of a bowed string, the gentle resonance of a plucked tone, and the clarity of a hammered note—all owe their character not merely to design, but to the innate properties of the wood from which they are made. The story of tonewood is, in essence, the story of music itself.

This book, *Properties and Treatment of Tonewood for String Instrument Construction—A Professional Guide*, is the conclusion of nearly three decades of my interdisciplinary research at the crossroads of wood science, acoustics, luthiery, and ethnomusicology. Its genesis lies in both professional necessity and intellectual curiosity. As a researcher of material sciences who has worked closely with luthiers and musicians, I observed a growing gap between traditional knowledge and modern scientific understanding. In an age where digital technologies can simulate sounds and AI can compose symphonies, it is more critical than ever to preserve, analyze, and advance our knowledge of the organic materials that continue to define the soul of acoustic music.

Tonewood, as a term, has often been used with a mixture of reverence and ambiguity. Instrument makers instinctively understand its value; scientists aim to quantify it. Yet, it remains one of the few materials in modern craft whose evaluation often depends on a knock, a feel, or a listening ear. This book aims to bridge the art and the science. It is designed not just for researchers or academics in wood science, but also for practical instrument makers, conservators, restoration specialists, musicians, and even policymakers concerned with the sustainable use of natural resources in cultural industries.

In the course of this work, special attention has been given to the orthotropic nature of wood—a key to its acoustic behavior. I have attempted to clarify concepts such as stiffness anisotropy, damping, longitudinal modulus, and internal friction, not through oversimplification, but through careful explanation, supported by diagrams, case studies, and reference data. Just as importantly, the book ventures into the treatment methods that have historically enhanced tonewood properties—from natural



seasoning and thermal modification to chemical applications and varnish techniques used by master luthiers like Stradivari and Guarneri.

This book is divided into thematic chapters that trace both the scientific underpinnings and historical applications of wood in string instrument construction. The initial chapters provide a historical overview, highlighting the centrality of wood in traditional instrument making from various cultures. From Persian barbats and Chinese pipas to Baroque violins and African koras. It is critical to remember that tonewood is not solely the domain of European classical instruments—it is a global phenomenon, shaped by local ecosystems and cultural traditions.

Subsequent chapters go into wood anatomy and identification, providing technical classifications of hardwoods and softwoods, cell structure, pore distribution, and the mechanical properties that determine tone. Later sections investigate acoustic properties and how they vary across species and processing methods. These are mainly informed by my own laboratory findings and fieldwork, and cross-referenced with recent peer-reviewed literature and international standards.

Beyond material properties, the book includes chapters on wood treatment methods. This encompasses both traditional empirical practices and modern engineering techniques. Methods such as thermal, non-chemical, and chemical treatments, along with the application of natural additives and varnishes, are described with attention to their scientific basis and acoustic outcomes. The reader will find ideas about the resurgence of neglected regional wood species that, with proper treatment and understanding, may substitute for endangered imports like rosewood or ebony.

Although the language of this book is primarily scientific and its structure methodical, it does not shy away from cultural narratives. Much of what we know and treasure about the acoustic character of wood comes from artisans, oral traditions, and regional philosophies of sound. For this reason, significant effort has been made to include ethnographic details about traditional instruments from Persia, India, Central Asia, Africa, the Middle East, Europe, and Indigenous American cultures. These traditions provide invaluable insights into how different societies interpreted and optimized their local woods for musical purposes.

This book would not have been possible without the collective wisdom of many colleagues. I am deeply indebted to master luthiers in Iran, Europe, and Türkiye who generously shared their knowledge, experience, and methods, teaching me to “hear” the wood as much as I could measure it.

I extend my gratitude to:

- **Professional Oud and/or Guitar Makers:** Mr. Ramin Fallah, Mr. Soroush Javadi Ashrafi, Mr. Mohammad Motiefar, Mr. Giuliano Nicoletti and Mr. Sina Asadi.
- **Experienced Luthiers of Persian Setar and Tar or Other Persian Instruments:** Mr. Mahdi Karimi Haghighi, Mr. Hamid Mahmoodi, Mr. Saeed Peymani, Mr. Hamidreza Samadi, Mr. Siamak Ghalami, Mr. Ehsan Ghassemi, and Mr. Abbas Salehi.

- **Renowned Violin Makers:** Mr. Mikaeil Ghazal, Mr. Ali Chavoshi, Mr. Masoud Ghafouri, Mr. Uluer Vardaloğlu, and Mr. Mohammad Norouzi, who have tested and continue to test my academic theories on their tonewood and instruments.
- **Tonewood supplier:** Mr. Sina Faramarzi

I also wish to thank my academic teachers in forestry and materials science, especially those who initially introduced me to the concept of acoustics of wood. Particular thanks goes to my French Ph.D. advisor, Dr. Joseph Gril, Research Professor of CNRS at the LMGC, University of Montpellier II, and my sabbatical host at the CIRAD Research Institute in Montpellier, France, Dr. Loïc Brancheriau, from whom I received invaluable training and assistance in working with wood acoustics. I am also grateful to my Ph.D. supervisor, Pr. Kazem Doost Hosseini from the University of Tehran, Iran, as well as the Turkish academic researcher and master luthier, Dr. Emir Değirmenli from Ankara Hacı Bayram Veli University, Turkish Music State Conservatory, whose support on double-top subject has been a great benefit.

I owe the techniques of instrumentation and the construction of measurement and evaluation tools for wood to the Hungarian professor, Dr. Ferenc Divos. His extensive teaching in the workshops of FAKOPP enterprise and the University of West Hungary, Sopron, along with numerous consulting sessions, has been and continues to be a profound inspiration throughout my journey. I would also like to express my gratitude to my esteemed academic colleague, Mr. Behzad Behnam, and his electronics team for their invaluable contribution in designing and constructing the laboratory equipment essential for my research.

I particularly thank the musicians who have shared their passion and taught me music, especially Mr. Behzad Mirkhani, Mr. Vaheed Roohnia, and Mr. Alireza Tafaghodi, masters of the classical guitar in Iran. They consistently reminded me that the ultimate goal of all these analyses is not theoretical perfection, but emotional connection.

I am grateful to AI services and their providers for their assistance in editing the grammar, spelling, and fluency of my written texts. Furthermore, AI has been instrumental in enhancing the quality of provided images and transforming my hand-drawn sketches into more aesthetically pleasing and expressive versions. I acknowledge this valuable contribution here and will specifically remind AI services in the caption of each relevant image.

Finally, my sincerest gratitude goes to the Turkish Handcraft Arts Association, which supports my scientific endeavors as a newly immigrated individual in Türkiye.

To the listeners, the audience, music students, and craftspeople who strive to achieve the perfect tone from musical instruments: this work is for you.

This book is not intended as a static manual, but as a living document of evolving practices. Readers are encouraged to approach it critically, to test its recommendations, and to expand upon its findings. Whether you are analyzing the cellular microstructure of spruce under a microscope, or selecting a well-seasoned mulberry blank by feel and instinct, your work matters to me. Every luthier and every researcher adds to the collective knowledge of our craft.

We live in a time where tradition meets innovation at every turn. Preserving the authenticity of tonewood does not mean resisting progress—it means understanding the essence of what gives music its breath and resonance. If this book contributes even a little to that understanding, it will have fulfilled its purpose.

Konya, Türkiye

Mehran Roohnia

**Competing Interests** The author has no competing interests to declare that are relevant to the content of this manuscript.

# Contents

<b>1</b>	<b>The Importance and History of Wood for Musical Instruments</b>	<b>1</b>
1.1	The Importance of Wood in Musical Instruments Industry and the Reasons for Choosing It as the Main Material	1
1.2	Historical Overview of the Use of Wood in Musical Instruments Industry	3
1.2.1	Early Instruments and Wood	3
1.2.2	The Baroque Era	4
1.2.3	The Classical Era and Beyond	5
1.2.4	Wood and Musical Instruments in Asia	6
1.2.5	Wood and Musical Instruments in America, Africa and Oceania	16
1.3	Final Words	18
	References	18
<b>2</b>	<b>The Basics of Wood Science and Wood Anatomy for Musical Instruments</b>	<b>23</b>
2.1	Wood Science: General Knowledge	24
2.1.1	The Importance of Wood Science	24
2.1.2	The Main Topics of Wood Science	24
2.1.3	Definition of Wood and Its Formation Process in the Tree	25
2.1.4	Types of Wood in Terms of Growth	26
2.1.5	Types of Wood in Terms of Deciduous and Coniferous	29
2.2	Physical and Mechanical Properties of Wood	35
2.2.1	Density and Specific Gravity	35
2.2.2	Moisture Content	37
2.2.3	Color	42
2.2.4	Grain and Texture of Wood	43
2.2.5	Strength	47
2.2.6	Stiffness	48
2.2.7	Poisson's Ratio	54

2.2.8	Toughness .....	57
2.2.9	Hardness .....	58
2.2.10	Workability .....	59
2.2.11	Wood Acoustic and Vibration .....	60
2.3	Wood Anatomy .....	61
2.3.1	The Cellular Structure of Wood .....	61
2.3.2	Annual Rings: A Closer Look .....	62
2.3.3	Wood Rays: The Vertical Connectors .....	64
2.3.4	The Microstructure of Wood Cells .....	64
2.4	Common Woods for Stringed Instruments .....	71
2.4.1	For Soundboards .....	71
2.4.2	For Backs and Sides .....	72
2.4.3	For Fingerboards and Neck .....	74
2.5	Final Words .....	75
	References .....	76
<b>3</b>	<b>The Physics of Sound and String Vibration: A Luthier's Perspective .....</b>	<b>81</b>
3.1	Concept of Vibration .....	82
3.1.1	Vibratory Motion and Waves .....	82
3.1.2	Simple Harmonic Motion (SHM) .....	82
3.1.3	Equations of Motion, Velocity, and Acceleration in Oscillations .....	84
3.1.4	Vibration and Waves .....	88
3.1.5	Wave Propagation in a Homogeneous Medium .....	95
3.1.6	Estimating Bridge Force in String Instruments: A Force Analysis Perspective .....	101
3.1.7	Wave Interference .....	105
3.2	Sound .....	107
3.2.1	Generation and Propagation of Sound .....	108
3.2.2	Speed of Sound Propagation .....	109
3.2.3	Sound Reflection .....	110
3.2.4	Sound Refraction .....	113
3.2.5	Sound Characteristics .....	114
3.2.6	Loudness Characteristic .....	115
3.2.7	Pitch Characteristic .....	118
3.2.8	Timbre—Sound Color .....	119
3.2.9	Sound Resonance .....	127
3.3	Sources of Musical Sounds .....	130
3.4	Air Columns: Sound Tubes .....	132
3.5	Final Words .....	134
	References .....	135

<b>4</b>	<b>Tonewood: Acoustic Identification</b>	139
4.1	Understanding Tonewood: A Key to Instrument Sound	140
4.2	Acoustic Properties of Wood for Musical Instruments	142
4.2.1	Density	142
4.2.2	Elastic Stiffness	148
4.2.3	Damping Capacity	172
4.2.4	Mechanical Impedance	182
4.2.5	Acoustic Radiation Coefficient	195
4.2.6	Acoustic Conversion Efficiency	196
4.2.7	Timbre and Sound Color	198
4.3	Components of Wooden Instruments and Their Required Acoustic Characteristics	204
4.3.1	Top-Plate or the Soundboard	206
4.3.2	Back-Plate, Back-Wall of the Resonance Box	207
4.3.3	Side-Wall of the Resonance Box	208
4.3.4	Bracings	209
4.3.5	Bass Bar/Tone Bar	209
4.3.6	Soundpost	211
4.3.7	Bridge and Saddle	213
4.3.8	Neck and Fingerboard	215
4.3.9	Bow	216
4.4	Final Words	218
	References	220
<b>5</b>	<b>Tonewood: Treatment and Tuning</b>	225
5.1	Review of Acoustic and Vibrational Parameters of Wood	226
5.1.1	The Motivation for the Wood Treatment	226
5.1.2	The Relationship Between Moisture and Wood	228
5.2	Wood Drying—A Foundational Acoustic Treatment	234
5.2.1	Air-Drying Wood Outdoors (Yard and Garden)	236
5.2.2	Drying Wood Indoors	238
5.2.3	Predicting Musical Properties of Properly Dried Wood	239
5.3	Chemical Treatments	241
5.3.1	Solvent Washing	241
5.3.2	Enhancing Acoustic Properties of Wood with Additives	246
5.3.3	Aging to Enhance the Acoustic Properties of Wood	249
5.3.4	The Effects of Varnishes	254
5.4	Physical or Mechanical Wood Treatments	259
5.4.1	Curving Wood	259
5.4.2	Brushing or Sandblasting to Adjust the Anisotropic Ratios	262
5.4.3	Multi-piece Plates: A Homogenization of Density and Stiffness	264

5.4.4	Carving and Thinning the Plates and Bracings .....	266
5.4.5	Drilling for Sound Holes .....	275
5.4.6	Bridge Tuning .....	276
5.4.7	Double-Top Plates .....	282
5.5	Final Words .....	284
	References .....	286
<b>6</b>	<b>Final Wooden Musical Instrument: Acoustic Tests .....</b>	<b>293</b>
6.1	What Is a Good Instrument Sound? .....	293
6.1.1	Resonance and Richness .....	294
6.1.2	Clarity and Definition .....	294
6.1.3	Other Factors .....	294
6.2	Software and Instrumentation .....	296
6.2.1	Importance .....	296
6.2.2	Sound Analysis with Data Export-Capable Software .....	297
6.2.3	Input Devices: Unidirectional Microphone .....	298
6.3	Frequency Response .....	299
6.3.1	Top Plate Tap Test .....	301
6.3.2	Back Bowl Tap Test .....	304
6.3.3	Frequency Response in a Completed Instrument .....	307
6.4	Sound Color Testing .....	311
6.5	Further Exercises .....	316
6.6	Final Words .....	316
	References .....	317



## About the Author

**Mehran Roohnia** was born in September 1971 in Tehran, into an Azeri Turkish family. He has an older brother who's a physician and a younger sister who's an accountant. His wife is a forestry engineer and his lonely daughter is still a middle-school student. The world of wood captivated him from a very young age. His maternal grandfather was a hereditary carpenter, and during summer school breaks, he would immerse himself in his workshop with incredible passion. He learned the invaluable crafts of sawing, gluing, joinery techniques, and the names of various wood species from him in those early years.

### Academic Pursuits and Research

After graduating from Alborz High School in Tehran, a beacon of educational excellence in Iran at the time, he entered the University of Tehran in 1990 to study Wood Science. In 1995, he pursued his master's degree in Wood Science at the Gorgan University of Agricultural Sciences and Natural Resources. His M.Sc. thesis, focused on the anatomy of wood and agricultural wood waste, was completed under the guidance of esteemed Professors, Prof. Seyed Zia-al-Din Hosseini and Prof. Ahmad Jahan Latibari.

Following a two-year hiatus for mandatory military service, he was accepted into the Ph.D. program in Wood Science at Islamic Azad University, Science and Research Branch, in 2000. His doctoral proposal, centered on the acoustic properties and damping capacity of mulberry and cypress wood, was approved with the guidance of Dr. Bernard Thibaut from the University of Montpellier 2, France, and Prof. Kazem Doosthosseini from the University of Tehran. Upon Dr. Thibaut's retirement, Prof. Kazem Doosthosseini took over as his thesis supervisor, with Dr. Joseph Gril, a research professor at CNRS France, serving as his advisor. He also spent time as a visiting Ph.D. student at the University of Montpellier 2, France, where he not only received thesis consultation but also utilized the university's advanced equipment for his acoustic and vibration tests.

### **Career Path and Scientific Endeavors**

Starting in February 2003, he began working as a scholarship instructor at Islamic Azad University. After defending his doctoral dissertation in May 2005 and a review of his educational and research portfolio, he was officially employed as an assistant professor at the university. He completed his 10-month sabbatical leave, during 2012 and 2013, focusing on wood vibration and acoustic assessments, under the supervision of Dr. Loïc Brancheriau at the CIRAD research institute in Montpellier, France. Over the years, through numerous research projects and the publication of their findings in prestigious reputable journals, he was promoted to an associate professor in 2011 and then to full professor in 2015.

### **Entrepreneurship and Relocation**

In 2016, he founded Darkoob NDT (instagram: @darkoob.ndt), a research company specializing in the acoustic assessment of wood and standing trees, within the Science and Technology Park of Islamic Azad University. The company was recognized as a knowledge-based company by the Vice-Presidency for Science and Technology of the Iranian Presidency in the same year.

Since 2021, he has been on extended leave from his university and relocated with his family to Türkiye. There, the Turkish Handcraft Arts Association has hosted and supported his scientific endeavors. This environment, free from conventional work concerns, allows him to calmly dedicate himself to writing and authorship. Many of the research projects he has conducted over the years have not yet been converted into articles, and he is currently focused on analyzing their data. Although he has transferred the responsibilities of Darkoob NDT to a partner company in Iran, he continues to provide online, remote consulting services.