StringTone Testing and Results

Test Objectives

The purpose of this audio test series is to determine if topical application of StringTone to strings of electric and acoustic musical instruments is effective in promoting improved sound and performance. Topical application will also be performed on the nut and bridge saddle of each instrument where the strings nest.

It should be noted that real-world environments are where the musician will be playing and listening to these various instruments whether it be a recording studio, concert hall or small bedroom. Sterile laboratory analysis would prove to be self-defeating as many musicians are more concerned with how “their” instrument will sound and perform in real-world environments.

Of course, real-world environments will yield different results depending on a number of acoustic factors too numerous to go into now, but suffice to say that direct input recording and close microphone placement were best suited for controlled testing purposes.

This is why we felt it was important to test a wide range of stringed instruments all of which have their own unique sound characteristics by virtue of materials and construction.

Testing Parameters

Independent third-party testing was performed on a wide variety of stringed instruments before and after direct application of StringTone. We have chosen one instrument from four major guitar categories to demonstrate the restoration and reconditioning capabilities of StringTone when applied to tarnished strings.

The instruments were recorded and tests performed in a small studio environment using direct-line or close microphone technique. This was done to rule out as many ambient acoustical influences as possible. A guitar chord was strummed, typically a fretted E, A or G, using a pick with a single down-stroke. The bass guitar open A-string was plucked using a pick with a single down-stroke. Minor details such as pickup selection (non-slanted, middle position for electric guitars), plectrum composition, applied force and attack, microphone and pick placement relative to bridge were also taken into consideration as these parameters affect tonal color of the instrument. Two dynamic cardioid microphones input directly to analog console were used for recording acoustic instruments: Joe Meek Model 67 and Sennheiser Model 441. Electric instrument input via M-Audio Fast Track Ultra direct box.

The testing methodology employed began with calibration of each sample based on RMS (average level) value. This was done in order to establish a base reference point prior to testing and analysis of each audio sample. The duration of each test sample ranged from 6 to 8 seconds from point of attack. Audio playback scale was referenced to K-System 14. Source file resolution was recorded at 32-bit, 48kHz (mono). Average (RMS) calibration level tolerance is +/-1.5db. Peak level measurements were < -1.0db.

Software Based Analysis

Comprehensive testing and analysis was performed using spectroscope, spectrometer and TFFT (time-based fast Fourier transform) software based instruments. We are displaying spectrometer test results here as they also provide a comparative visual contrast of before and after product application. The spectrometer, a commonly used tool by audio engineers, is especially useful in displaying a continuous frequency graph, providing very precise and detailed real-time frequency analysis. Frequency spectrum comparisons are shown here as an overlay of both before (grayscale) and after (color) linear displays.

Diagnostic Summary from Spectrometer Test Images

First of all, we will establish the fundamental and harmonic ranges of each instrument to help you better understand what our test results yielded. We are measuring a composite waveform(s); simply put the combination of fundamental and harmonic (partials) frequencies. It's also important to note that an instrument's unique tonal color is the result of the multiples (harmonics) of the fundamental note.

Acoustic Guitar (Epiphone EC-20 Classical Guitar)

The fundamental range of the acoustic guitar is approximately 82-988 Hz with the harmonic range from 1 kHz to 15 kHz. What gives the classical guitar its unique tonal quality is the combination of construction, materials, along with nylon and nylon gut stings. We tested an Epiphone EC-20 Classical Guitar with badly tarnished Augustine "Blue" strings. Results from the test showed a modest improvement in the fundamental frequency range. There was a marked improvement starting with the low mid-range (low order harmonics) which affects the presence of the guitar. We see a continuation of this trend into the upper midrange from 4 kHz to 6 kHz areas responsible for clarity and definition of the instrument. The improved response from the 6 kHz up to 16 kHz range restored the crispness of string attack and brightness of tone. The application of StringTone brought the original tonal quality of the instrument "back to life" restoring a balance of fundamental and upper harmonic frequencies.

Electric Bass Guitar (Ibanez 4-String)

We need to briefly discuss why physics does not allow the use of solid strings to achieve low frequencies especially on an electric bass guitar. For strings of finite stiffness, the harmonic frequencies will depart progressively from the mathematical harmonics. Winding additional wire around a solid wire core makes possible the increasing of mass without adding excessive stiffness. This keeps the string frequencies closer to the frequencies of an ideal string. The fundamental range of the electric bass guitar is approximately 41-300 Hz with the harmonic range from 1 kHz to 7 kHz. The Ibanez 4-string bass was tested with used Fender nickel wound medium gauge strings. Test results clearly show a dramatic improvement in the lower order harmonics above the fundamental frequencies into the 2.5 kHz range. Applying StringTone clearly improved the flexibility of larger mass strings of the bass. This application allowed the strings to vibrate in a more "ideal" mode producing better harmonic response with more instrument definition. The muddiness in the bottom end was cleaned up very nicely with StringTone which resulted in a more balanced tonal quality. Nearly all of the bass guitars in our test group showed similar results with StringTone application.

Acoustic Guitar (Martin D-35 Dreadnaught)

The fundamental range of the acoustic guitar is approximately 82-988 Hz with the harmonic range from 1 kHz to 15 kHz. The used medium gauge, bronze strings on the Martin D-35 acoustic guitar showed a marked improvement in the fundamental frequencies. Fundamental frequencies determine where an instrument "sits" in a music mix. We see a steady improvement from the lower to upper harmonic range with this application. Note that strings of certain composition, especially bronze, loose their luster quickly if not cleaned regularly. The classic Martin D-35 also tends to be more robust in the "bottom" end compared to the D-28 model. StringTone worked well on this large body dreadnaught by restoring clarity and presence to the instrument immediately with one application.

Electric Guitar (Fender Stratocaster)

The fundamental range of the electric guitar (direct) is approximately 82-1319 Hz with the harmonic range from 1 kHz to 15 kHz. What gives electric guitars their unique tonal quality is mainly the type and positioning of the pickups in combination with construction. The classic Fender Stratocaster guitar was presented with a set of used Ernie Ball nickel wound, 9-42 gauge strings. We measured improvements in the upper fundamental frequency range around 500 Hz to 1 kHz which added slightly more definition to the instrument. Instrument clarity improved starting with harmonic improvement from the 2 kHz – 8 kHz range where some of that characteristic string "bite" resides depending on selection and position of the pickup. These results were not as dramatic as some of our other instrument test results, but we did see a measured response and improved sonic quality with the StringTone application to this model.

Summary and Conclusions

Quantitative Analysis

The test results show that the application of StringTone does improve the sound and performance of the musical instruments that were tested. The frequency output results ranged from modest improvements in most of the electric guitars to more dramatic results with the bass guitars we tested. The upper register instruments like mandolins responded very well with smoother frequency output, improved upper harmonics, and increased sustain.

Subjective Listening Tests

A/B testing in a studio environment, considered by some to be objective, is still subjective and by no means a definitive measure of performance. We concluded after listening to each test sample there is discernible improvement in instrument tonal clarity, resulting in a more balance between fundamental and harmonic frequencies. The most dramatic improvements again were clearly apparent in larger mass strings of the bass guitar.

Qualitative Analysis

An instrument string is essentially suspended between two points, in the case of a guitar, a nut and bridge. The distance between these two points will determine the frequency or pitch of the string. Three main elements: construction, gauge and tension of the string will determine its octave tuning range. The concert pitch (equal-tempered) for Spanish guitar open A-string tuning is 440Hz. When a string is pressed down on any fret along the neck of the guitar you are simply changing the distance between the two points of suspension and thus the pitch.

It is well known that musical instrument strings and metal surfaces are subject to oxidation and corrosion. They are constantly subjected to skin oils, perspiration and other environmental contaminants. One of the areas not commonly examined is what happens to a musical instrument string when it is plucked.

When instrument strings are plucked they oscillate which means they vibrate at a fundamental pitch with associated harmonics along the length of the string. This means the string is not only moving vertically, but horizontally along the plane of neck. This simultaneous movement is where microscopic friction and abrasion are created in the internal core of a wrapped string as well as the grooves of the nut and bridge saddle. Microscopic internal and external friction is increased in the case of larger diameter bass guitar strings that vibrate at lower frequencies with increased motion and energy due to mass dynamics. String abrasion is also increased with metal bridge grooves. There are other factors affecting string performance at the molecular level such as metal composition and surface irregularities.

When a string is pressed down on a metal fret of a guitar neck a depression on the underside of the sting will eventually form depending on the number of times the string is “fretted” at that point. Certain styles of guitar playing like blues and rock will often include stretching and bending strings during a performance. This also increases stress and abrasion on the strings, nut and bridge grooves. When guitar stings are played hard and over stressed they break readily, especially the high-E, D, and G strings of narrow gauge string sets. They usually break at the bridge or the point of highest tension.

We noted that after applying StringTone to musical instrument strings, bridge area and nut, resulted in reduced surface abrasion along with significantly lower internal and external string friction. The after application tactile response yielded a slightly smoother feel and a more flexible string without any excessive residue. This clearly demonstrates the barrier lubricant properties of StringTone when applied to irregular surfaces. A slightly more flexible string indicates reduced surface tension. These test results would also indicate that StringTone can be used as a preventative surface treatment and barrier lubricant in all mechanical applications for a wide range of musical instruments. Conclusive test results clearly show that the penetrating, barrier lubrication and restorative properties of StingTone not only produced measurable results, but prolong the life and sonic quality of musical instrument strings.