A STUDY ON TIMBRE ADJUSTMENT OF ELECTRIC GUITAR BASED ON VIBRATION CONTROL OF PICKUP BASE

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Abstract

Electric guitars are world wide used instruments in particular among young ages. Their timbre or impression of tone is different respectively without consideration of characteristics of amplifier or speakers. Then, artists change the guitars sometime to adjust the timbre for each music impression. The basic structure of electric guitar is very similar with stereophonic equipment. That is, the tone signal is detected from string vibration by using electro-magnetic pickup, sent from pickup to guitar amplifier through shield cable, amplified and radiated from a speaker. On the other hand, mechanical vibration caused on strings propagates to the body through nut-neck and/or bridge, reach and excite pickup indirectly, and finally cause the particular tone. Furthermore, the vibration on the body seems fed back to the strings. This mutual feedback system on vibration built up the particular timbre of individual instruments.

In this study, how the vibration characteristics on the base of pickup influences to the electrical signal output or its timbre of an electric guitar is studied from experimental viewpoint. Especially, how the mechanical characteristics like the stiffness, the damping factor and density of materials are related to the change of timbre has been researched for popular and inexpensive one. In the experiment, we employed nine kinds of materials of wood, metal and plastic. The difference of materials is appeared in difference on amount of higher harmonics and damping factor at just after of picking and sustain part of string vibration. In consequence, by changing the materials of pickup base, the timbre of output tone from electric guitar changes based on the characteristics of material, and tendency of timbre are roughly related to mechanical characteristics.

1. INTRODUCTION

An electric guitar is popular and widely used instrument from young age to middle age in wide types of music. It has own timbre individually designed by maker. Usually, its sound is electrically processed by using an effector or guitar amplifier to add some effects like reverberation or distortion by player according to motif of music. But, as the effector could not change its essential timbre, artists change the guitars to adjust its timbre to music impression.

An electric guitar is usually consists of wooden solid body, neck, electromagnetic pickup, strings and electric parts. As mentioned by Fletcher and Rossing[1], vibrations of the body are relatively unimportant, and since the strings transfer relatively little energy to the body, electric
guitars are characterized by a long sustain time. The solid-body electric guitar is less susceptible to acoustic feedback in comparing with an acoustic guitar. Though relatively little energy is transferred to the body, the vibration occurred on each component excited by vibrating strings cause vibratory effects on the pickup coils which should be kept fixed position to detect the accurate motion of vibrating strings. Because of this slight effect of vibration through guitar components, the electric output signal from the pickup coils would make up individual timbre of each electric guitar just like stereophonic LP player. So, this influence of component materials becomes important one on its timbre. When we consider an electric guitar as stereophonic equipment, many previous studies [2-5] become useful to grade up the sound quality of guitar. Based on our previous study on stereophonic equipments [6,7], as the influence of vibration on equipments to electric signal is obvious one, there is a good possibility to change the timbre of electric guitar by controlling transmitting pass of vibration to pickups.

In this study, a new trial on change or control in timbre of electric guitar by treating the supporting system of pickup coils. That is, by considering the effect of vibration on guitar body to pickup coils, change of pickup coils’ supporting system may be effective to change timbre of guitar because of the change of transmission characteristics from body to pickup coils. In the experiment, three types of materials iron, copper and wood had been employed as insertion materials. To be concrete, we employed cast iron, steel, soft iron, copper, brass, oak, agathis and MDF to make up test pieces of pick guards. To evaluate the difference on effects of materials, spectrum of electric output signal from pickup coil was measured for each material. Hearing tests were carried out to evaluate the change of timbre due to material for about 40 students. Consequently, we could find out a possibility on changing the timbre of electric guitar by controlling the material of pick guard.

2. METHOD ON MODIFICATION OF ELECTRIC GUITAR

2.1 Structure of Electric Guitar

A popular edition of electric guitar was employed to modify around pickups. As shown in Fig. 1(a), the pickups were mounted on a pick guard made by plastic plate, and separated from body of the guitar. So, the pickup coils are greatly influenced by vibratory characteristics of pick guard. Then, vibration caused on the body is transmitted to pickup coils through pick guard. In this study, we tried to control the timbre of the guitar by replacing the guard surrounding the pickup made by different material as shown in Fig. 1 (b). As the pickup coils are directly mounted new pick guard but indirectly connected to the body, timbre of this guitar is influenced by the characteristics of pick guard.

2.2 Materials of Pick Guard

In this study, we employed nine kinds of materials, cast iron (FC), steel (SK5), iron (SS400),