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New Monsha Lacquerware Painting Using Woodceramics

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The objective of the current study was to improve the poor wear resistaince of lacquerware through the use of New Sha produced from woodceramics which were made by the process of materials such as cypress and beech chips being impregnated with phenolic resin and carbonized in a vacuum furnace. The results demonstrated that a coating on a wooden board of powdered woodceramics carbonized at 800°C had lower friction coefficients and the wear resistance approximately 3–4 times as high as compared with a similar coating of the commonly used rice blown carbonized at 650°C.

Key words: woodceramics, Tsugaru Lacquerware, friction-wear property

1. INTRODUCTION

Among the various Tsugaru Lacquerware techniques, the *monsha* type is known as the most durable with good resistance to discoloration and damage. *Mon* refers to the pattern of the lacquer and *sha* refers to the carbonized rice hulls used in the process. The production of *monsha* lacquerware entails a difficult process requiring much time to produce the carbonized rice hulls and highly skilled polishing techniques. The traditional method of manufacturing *sha* has been to burn rice hulls in the field under uncontrolled temperatures, which explains why it is impossible to achieve a consistent hardness. Secondly, wood chips from trees grown in Aomori Prefecture, such as Aomori cypress and beech, were impregnated with phenolic resin and carbonized in a vacuum furnace. New Sha was produced from the resulting woodceramics and used in experiments aiming to improve the poor friction and wear resistance properties of lacquerware. the current study firstly confirmed the friction and wear properties of bulk woodceramics materials [1] [2] [3].

2. EXPERIMENTAL PROCEDURE

Powdered rice hulls and chips of Aomori cypress (*Thujopsis dolabrata* Sieb. et Zucc.), apple trees, false acacia (*Robinia pseudoacasia linn*), and beech trees (*Fagus crenata* Blume) were used as raw materials for the present study. As shown in Figure 1, the materials were impregnated with phenolic resin at a ratio of 1:1 and carbonized at 600°C or 800°C. The resulting powdered woodceramics was then applied to a lacquer-coated board and hardened. A second layer of lacquer and woodceramics powder was applied and hardened and then the surface was polished. Total film thickness was 1 mm.

The friction-wear apparatus (sliding distance and volume) used in this study was a Lhesca Thin Film Friction Player FPR-2000 (Figure 2). Experiments were carried out in air at room temperature. An alumina ball was pressed onto the material with a 500g load and the changes in friction coefficient were consecutively measured as the material was rotated. The test was carried out up to a friction distance of 500m at 4mm radius of gyration and 6.3 cm/s rotational speed. The friction coefficient was calculated by measuring the value of the frictional force with a strain gauge and dividing that by the load. Section profile of worn scars in this study are also measured using a scanning of surface forms (Veeco, DEKTAC3 Co., Ltd.) Long sliding distance and low sliding volume means good properties.

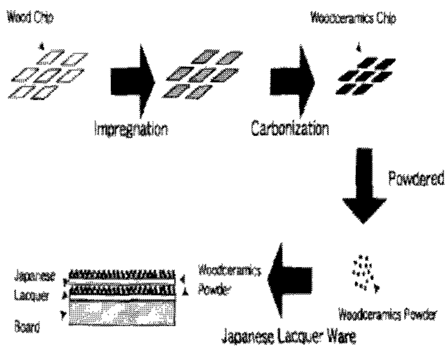

Fig. 1 The process of manufacturing a New Monsha lacquerware using Woodceramics.

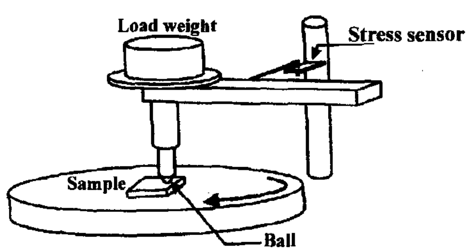

Fig. 2 Schematic diagram of a friction-wear apparatus.

3. RESULTS AND DISCUSSION

3.1 Friction/Wear Properties of Bulk Material

The results of the evaluation of the fundamental friction and wear characteristics showed that bulk woodceramics were anisotropic and had a remarkably low friction coefficient of 0.17 and a low sliding volume. Because the bulk materials for woodceramics are commercialized medium density fiberboard (dried specific gravity: 0.69) made from Pinus radiate, as shown in Figure 3, the friction and wear properties expressed differing values on the cross and vertical section surfaces. Medium density fiberboard manufactured from different raw materials is used as the bulk material to make woodceramics, variations in friction coefficient values are seen: 0.16 to 0.18 on vertical section surfaces and 0.12 to 0.20 on cross section surfaces. Values on the vertical section surfaces were more uniform than those on the cross section surfaces.These results suggest that the material will be useful for hard coatings.

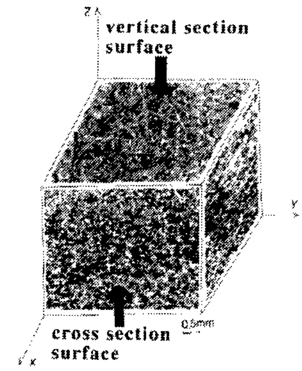

Fig. 3 A section of woodceramics using medium density fiberboard.

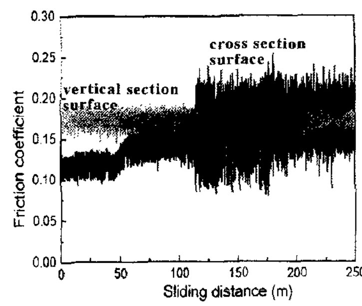

Fig. 4 The friction and wear properties of woodceramics made from medium density fiberboard carbonized at 800°C.

3.2 Friction/Wear Properties of Coatings

The friction properties were investigated to examine the suitability of the New Monsha process shown in Figure 1 for practical application in lacquerware products. A photograph of the surface of New Monsha lacquerware is shown in Figure 5. The friction/wear coefficients and sliding distances of field burned rice hulls carbonized at 650°C, powdered beech carbonized at 600°C, and powdered beech carbonized at 800°C are shown in Figure 6. The friction coefficient of field-burned rice hulls carbonized at 650°C was 0.58 and the friction distance was 110m. The sliding volume on the outer surface was 3.08mm^3. The powdered beech carbonized at 600°C had a friction coefficient of 0.5, lower than that of the field-burned rice hulls carbonized at 650°C. The sliding volume was 1.61mm^3. Of all the tested materials, the powdered beech carbonized at 800°C had the lowest friction coefficient at 0.4 and its sliding volume of 0.86mm^3 was one-third of that of the traditionally used rice hulls. Therefore, the 800°C powdered beech had a lower wear amount. The result showed that the new Monsha lacquerware painting was stronger than traditional painting.

Fig. 5 Photograph of surface of New Monsha lacquerware.painting

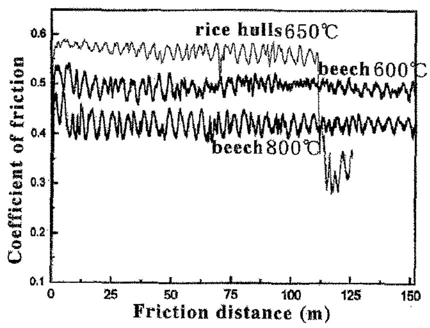

Fig. 6 The friction/wear properties of the surfaces of lacquer coatings using powdered woodceramics.

3.3 Friction/Wear Testing of Coatings Made from the Various Materials

The relationship between the friction coefficients and friction distances, and the worn scar profiles of coatings made with rice hulls, apple trees, acacia, beech and cypress are shown in Figures 7–16, respectively. In all materials, friction coefficient was about 0.3, but the values for acacia had a tendency to vary largely. In all materials except for rice hulls, the worn scar profiles were approximately the same size. That of rice hulls was larger than that of the others, confirming that there are differences depending on materials. The size of worn scars in coatings using powdered woodceramics made from chips ranged from 0.8 to 1.7mm. In coating using powdered woodceramics made from apple trees, the size was 1.5mm and in that made from carbonized rice hulls, it was 2.0mm.

Figure 17 shows some examples of the practical application of New Monsha lacquerware. We intend to further pursue the development of such products through both basic and practical application studies.

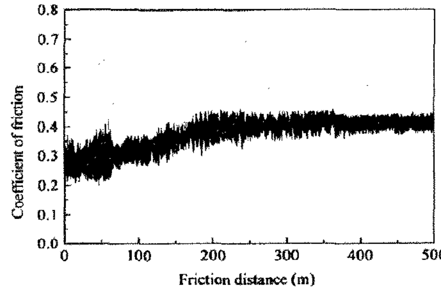

Fig. 7 The relationship between friction coefficient and friction distance of rice hulls.

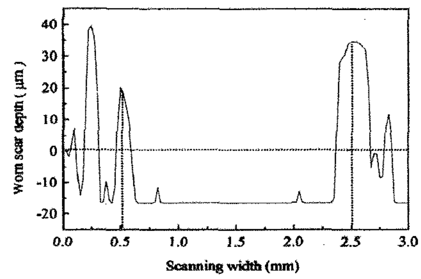

Fig. 8 Section profile of worn scar of rice hulls.

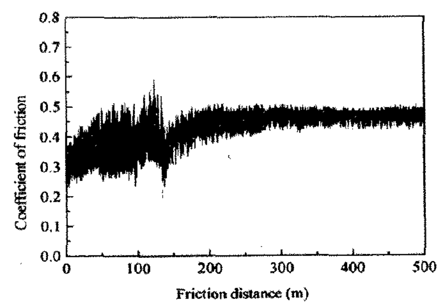

Fig. 9 The relationship between friction coefficient and friction distance of apple trees.

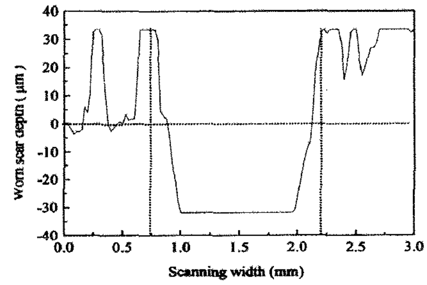

Fig. 10 Section profile of worn scar of apple trees.

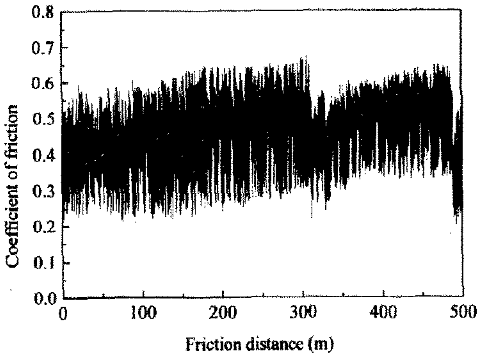

Fig. 11 The relationship between friction coefficient and friction distance of false acacia.

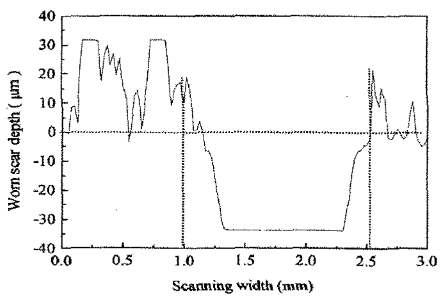

Fig. 12 Section profile of worn scar of false acacia.

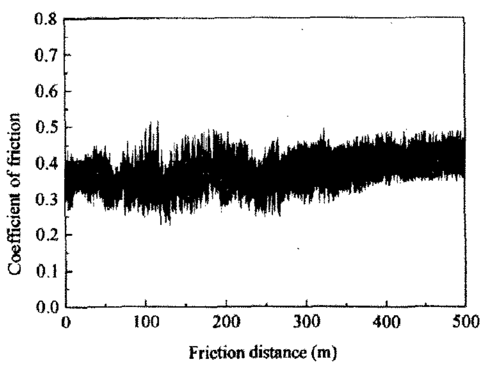

Fig. 13 The relationship between friction coefficient and friction distance of beech trees.

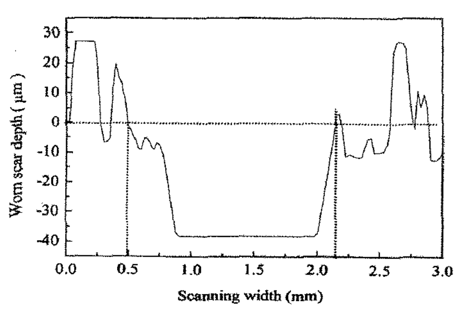

Fig. 14 Section profile of worn scar of beech trees.

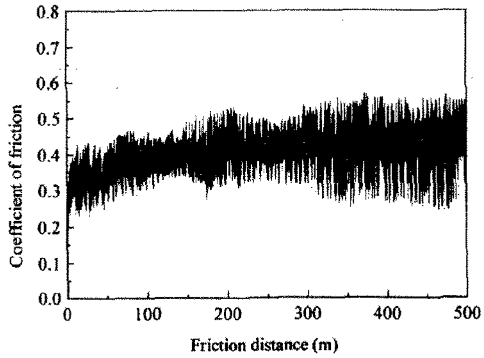

Fig. 15 The relationship between friction coefficient and friction distance of Aomori cypress.

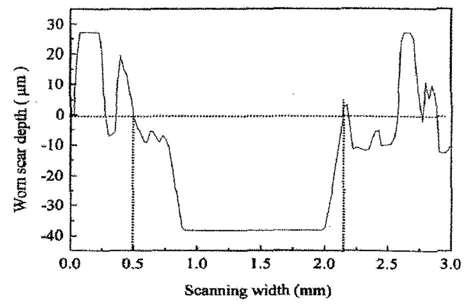

Fig. 16 Section profile of worn scar of Aomori cypress.

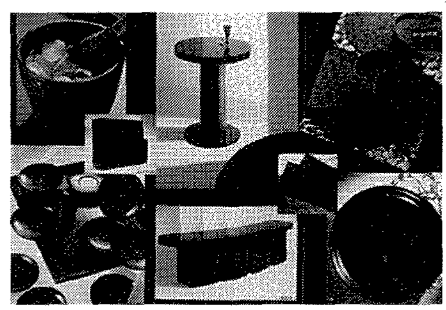

Fig. 17 Examples of New Monsha lacquerware painting products.

4. CONCLUSIONS

Coating made from powdered woodceramics carbonized at 800°C and applied to the surface of a board had a lower friction coefficient and was more resistant to wear than the traditionally used rice hulls carbonized at 650°C.

REFERENCES

[1] T.Okabe and K.Saito, J.of Porous Materials 2,215-221(1996).

[2] T.Okabe and K.Saito, J.of Porous Materials 2,223-228(1996).

[3] K.Hokkirigawa, T.Okabe and K.Saito, J.of Porous Materials 2,229-235(1996).

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