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Fabrication of LTCC Multilayer Substrate Using Photo Resist Film and Doctor Blade Method

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Abstract: A new method which uses photo resist film to prepare Low Temperature Co-fired Ceramics (LTCC) multilayer substrate is proposed. In this method, the photo resist film was exposed and developed to form designed sacrifice patterns first. Then the sacrifice pattern was filled with LTCC slurry used doctor blade method. After this process, the sacrifice pattern was dissolved and removed to form designed empty area corresponding to both cavity structure and conductive pattern on the green sheet. In the case of conductive pattern, the empty area was filled with conductive paste. This method achieved the internal conductor pattern and the cavity structure inside the LTCC multilayer substrate.

1． Introduction

Miniaturization of electronic devices and other communication devices has required. Therefore, revision of the material of the electronics substrate was studied, and as a practical system Low Temprature Co-fired Ceramics (LTCC) has been applied for the high frequency module substrate. LTCC show slow loss propaty because it can be fired with conductive metal that has low resistance such as silver or copper. However, the conventional fabrication methods of the LTCC substrate has some problems.

Conventionally, the formation method of the through empty area for via conductor between upper layer and lower layer on the LTCC green sheet is the laser punching. Also, the formation of the empty area corresponding to the cavity structure on the LTCC green sheet is done by the mechanical die punching method. Moreover the electrode and the circuit pattern formation on the LTCC green sheet is by the screen printing method.

However, these methods become difficult to progress further miniaturization because the laser beam has a limit of the focus due to the diffraction phenomena. On the other hand, the conductor deforms when the screen printing method was used due to mesh impact and so on.

The new method using photo resist film and doctor blade method was proposed to replace the conventional method. In this process, miniaturization of the patterning achieves more than the conventional method because photolithographic technology is applied. Also, the conductive paste does not deforme because the paste was sustaind by the through empty area. Moreover, this process can respond to the flexible changing of the design than the conventional method.

2． Experimental Procedure

The schematic illustration of the sample structure of the LTCC multilayer substrate was shown in Fig. 1.

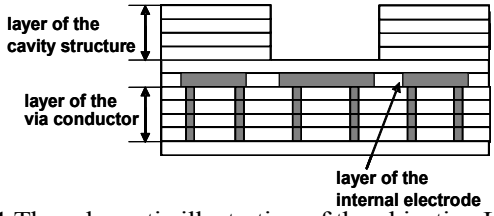

Fig.1 The schematic illustration of the objective LTCC multilayer substrate.

In first step, the photo resist film was exposed optically and developed chemically to form the designed sacrifice pattern. Then, the sacrifice pattern was filled with LTCC slurry using doctor blade. After the filling process, the sacrifice pattern was dissolved to form green sheet with through empty area. In the case of the process of the cavity structure, a number of the green sheets with the through empty area were stacked. Then, the plane bottom layers of the cavity structure were stacked with the first green sheet. Then, the layered specimen was fired. Through these processes, the LTCC substrate with the cavity structure was achieved. Fig. 2 shows the schematic illustration of the process for producing the cavity structure.

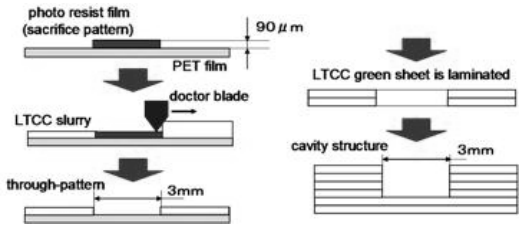

Fig.2 The process of the cavity structure.

In the case of the process of the through internal electrode,

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it was obtained by filling the conductive paste inside the empty area using doctor blade. Fig. 3 shows the schematic illustration of the process for producing the through internal electrodes. At this time, the green sheet was covered with the resist film remaining the through-hole points open. Then the conductive paste was filled into the through empty area on the green sheet. After drying process, the resist film was dissolved and peeled off. And then the green sheet was stacked and fired.

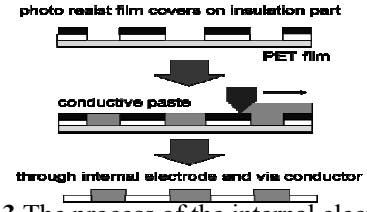
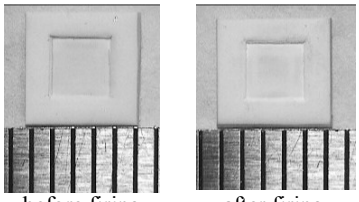


Fig. 3 The process of the internal electrode.

3． Result and discussion

The optical microscope images of the laminated green sheets and the fired substrate are shown in Fig. 4 respectively; Fig. 4 shows the top surface of the specimen. The shrinkage of the surface direction was 18%. And the coplanality of LTCC multilayer substrate was 0.5μm.



before firing　　after firing

Fig.4 The result of the cavity structure.

The Scanning Electron Microscope (SEM) image of the cross-section of the part of the cavity structure after firing is shown in Fig.5. It was observed the depth of the cavity structure after firing was 150μm.

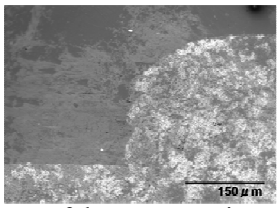
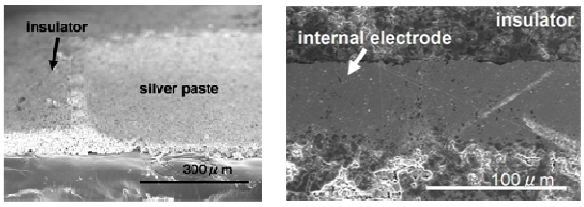


Fig. 5 The image of the cross-section of a part of the cavity structure.

The SEM images of the cross-section of the internal electrode are shown in Fig. 6. The surface of the LTCC green sheet with internal electrode is shown in left figure. The cross-section of the internal electrode is shown in right figure.



before firing　　after firing

Fig. 6 The image of the internal electrode

The figure shows that the conductive paste was completely filled the through-hole of the internal electrode. Moreover, the deformation when occurs during the screen printing method was not observed. In addition, the penetrating conductor pattern was achieved.

Fig. 7 shows the cross sectional view of the fired LTCC multilayer substrate. In this figure, the cavity structure and the internal electrode were observed. The size of the thickness was 393[μm] after firing. Also, the shrinkage of the thickness was 13[%].

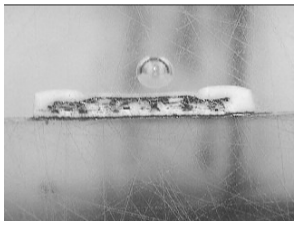


Fig. 7 Optical microscope image of LTCC multilayer substrate.

4． Conclusion

The LTCC multilayer substrate with the cavity structure, the penetrated internal electrode was achieved. Shrinkage of the surface direction of the cavity structure was 18%. The depth of the cavity structure after firing of 150μm was obtained. The conductive paste was completely filled the through-hole of the internal electrode, and penetrating. The internal electrode was flat. And the coplanality of LTCC multilayer substrate was 0.5μm.

Acknowledgments

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Reference

[1] F. Uchikoba, J. Tane, S. Park and K. Yamashita “A New Through Hole Formation Method on LTCC Green Sheet Using a Photo Resist Film”, Proc. of International Conference on Electronics Packaging 2007 ICEP, pp. 318-322, 2007.