Micro Co-molding of Laminated Ceramic Material by Imprinting Method

K. Tokumaru[1] and F. Tsumori[1]

[1]*Department of Mechanical Engineering, Kyushu University, Japan*

e-mail: 3TE17658G@s.kyushu-u.ac.jp

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Ceramic has excellent properties such as heat resistance and chemical resistance, and it is often used as a material for high function products. Solid oxide fuel cells (SOFC) is a typical example. In SOFC, laminated ceramics play an important role.

The aim of our study is the development of a micro co-molding process for laminated ceramic materials. Figure 1 shows schematic images of our method. The starting material was a laminated ceramic green sheet. In the imprinting process, the laminated sheet was hot-pressed with a mold and the pattern on the mold was transferred to the surface of the laminated sheet. At this process, the interface between the laminated layers deformed simultaneously with the top surface. After imprint, the laminated green sheet was heated in a furnace. In this sintering process, the polymer binder material in the green sheet was decomposed and the ceramic powder solidified.

In our study, we applied this method for two targets. One was for improvement of the SOFC performance, and the other was fabrication of a ceramic microchannel. Figure 2 (a) shows schematic image of the designed SOFC. It has a three-layer structure; an anode, an electrolyte and a cathode. The current is generated by reaction of hydrogen and oxygen on the laminated interfaces. As the area of the interface increases, the reaction amount increases. In this study, we printed line-and-space pattern on compound sheet for the electrolyte laminated with the sheet for the anode. Figure 2 (b) shows a cross-sectional image of the laminated sheet. The upper layer was an electrolyte sheet and lower sheet was an anode sheet. The thickness of the upper layer was 30 μm and the lower layer was 400 μm. Figure 2 (c) shows the imprinted sheet. The upper layer was formed in wavy shape. The pitch of pattern was 150 μm and the amplitude was 70 μm.

Figure 3 (a) shows a cross-sectional image of an alumina microchannel and Fig. 3 (b) shows CT scanned image of the alumina channel. This sample had wavy channels along wavy pattern on surface of alumina body (black line in Fig. 3 (a)). The channels in alumina body was fabricated by decomposed of the sacrificial sheet made of a polymer film. The sacrificial sheet was embedded between two alumina compound sheets and formed in wavy shape by imprinted at the same time as compound. The sacrificial sheet was burned out in sintering process and cavities was formed where the sheet was present.

Using our method, we could easily fabricate ceramic products with complex shapes. In addition, this method is applicable to various ceramic products.

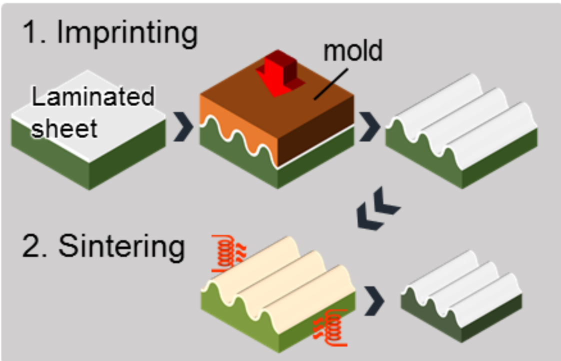

Figure 1. Image of the processing flow of the present method.

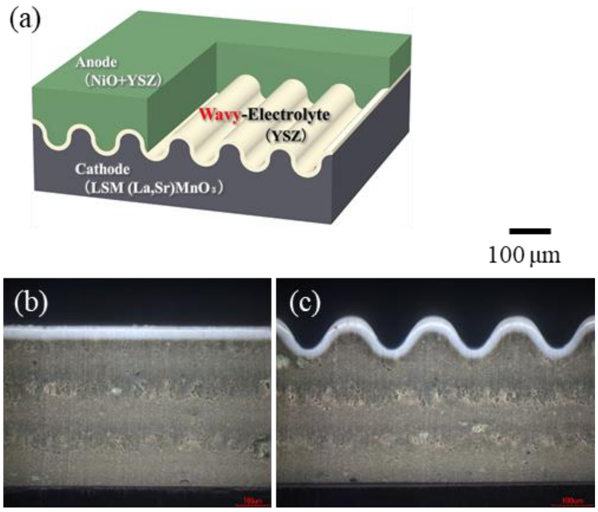

Figure 2. (a) is schematic image of our aiming SOFC. (b) is laminated compound sheet for SOFC and (c) is imprinted

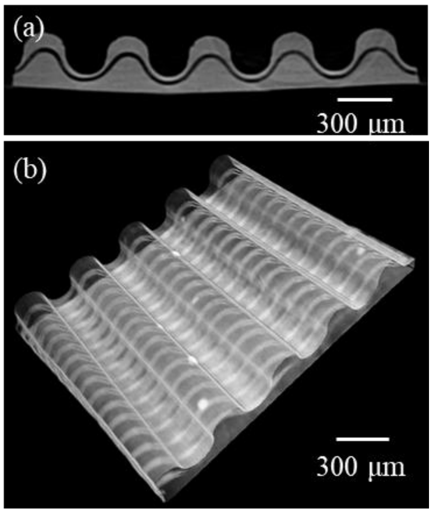

Figure 3. (d) is a cross-sectional image of an alumina microchannel and (e) shows CT scanned image of alumina channel.