Porous Ni-Zn ferrite ceramic was prepared using wood template. The wood specimen was treated with ammonia and infiltrated by slurry of nickel nitrate, zinc nitrate and iron (III) and sintered. The products contained mainly ferrite and hematite. The single phase of ferrite formed at 1200°C for 8h, at 1300°C for 6h, at 1400°C for 2h and at 1500°C for 1 h. The shrinkage of specimen size was obvious when sintered at higher temperature. SEM images confirmed that the sintering at higher temperature promotes the grain growth and at the same time causes the pore size to contract. The microstructure of wood retained.

Key words: NiZn ferrite, hematite, Porous ceramic, Natural template, Wood

1. INTRODUCTION

Porous ceramics have become important material for a wide application such as thermal and/or sound insulation, absorption, filtration and as catalysts [1]. Design of novel ceramic structures by mimicking the cellular tissue anatomy of native lignocellulosic structure such as wood has recently attained increasing interest [2]. In this study, we had prepared porous Ni-Zn ferrites ceramics using natural templates (wood), which might be applied in Electro-Magnetic Transmission (EMT) shielding purposes.

2. EXPERIMENTAL

The starting materials used in the preparation were nickel nitrate (Wako), zinc nitrate (Wako), iron (III) nitrate (Wako). These chemicals were weighed according to the required stoichiometric proportion of Ni$_{0.5}$Zn$_{0.5}$Fe$_2$O$_4$. Slurry of Ni, Zn and Fe nitrates in concentration of 1 mol/l was prepared at 65°C with stirring for 10 – 15 minutes.

![Fig 1. SEM image (a) and EDS mapping of the infiltrated wood by Ni, Zn, Fe nitrates slurry: Iron (b), Nickel (c), and Zinc (d).](image-url)
Mostly cypress were used as the wood templates and wood specimens (40 x 30 x 10 mm) were boiled with the 25% ammonia for 1 h to remove the wood extractive compounds, washed with water before re-boiled again with deionized water for 1-2 h. The boiled specimens were infiltrated by mixed slurry of Ni, Zn and Fe nitrates at room temperature to 60°C for 1 – 9 days and dried at 100°C for 1 day. Finally, the samples were sintered at various temperatures between 900°C – 1500°C for 1 - 8 h. The products were identified using XRD (RINT 1100, Rigaku) and observed by SEM (JSM-6100, JEOL) and EDS (JED 2001, JEOL).

RESULTS AND DISCUSSION

Figure 1 (a) shows the SEM photograph of infiltrated wood. Ni, Zn, Fe nitrates slurry entered in vessels and cell of wood specimen. As shown in Fig. 1(b) to (d), the Ni, Zn and Fe elements were homogeneously infiltrated in a wood template. Figures 2 and 3 shows the X ray diffraction patterns of the infiltrated specimen sintered at various temperatures for 2 and 8 h. It is obvious that the characteristic peaks for spinel nickel zinc ferrite appeared in all samples as the main crystalline phase. The ferrite phase became dominant at higher temperatures and/or for longer sintering time. The single phase of ferrite formed at 1200°C for 8h, at 1300°C for 6h, at 1400°C for 2h and at 1500°C for 1 h. These results are summarized in Fig.4. As the ferrite content of specimen increased, color of specimen changed from brown to black and the specimen became more magnetized.

Fig 2. XRD patterns of specimens sintered at 1050°C – 1400°C for 2 h.

Fig 3. XRD patterns of specimens sintered at 1000°C – 1300°C for 8 h.
Fig 4. Transformation curve for NiZn-ferrite + hematite to 100% NiZn-ferrite in the range 1100°C to 1500°C within 10 h.

Figure 5 (a) shows SEM image of original wood which is cover up by the natural layer and Fig 5 (b) microstructure after boiled with 25% ammonia for 1 h. The wood extractive compounds were completely removed. Figure 6 shows SEM images of specimens sintered at various temperatures. It was confirmed that sintering at higher temperatures and/or for longer time promoted the grain growth and the pore size to contract simultaneously. The coarse grains led to an increase in the strut thickness, resulted the pores with smaller sizes.

Fig 5. SEM images of original wood (a) and wood templates after boiled with 25% ammonia for 1 h (b).

Fig 6. SEM images of specimen after sinter at 1000°C for 2 h (a), 1000°C for 8 h (b), 1200°C for 8 h (c), and 1400°C for 2 h (d).
The sintering at higher temperatures increased shrinkages (Table I). Figure 7 shows the typical appearance of the specimen after sintering. It is thought that rapid shrinkage by sintering at higher temperature caused much cracks of specimens.

Table I. Shrinkage due to temperature and time

<table>
<thead>
<tr>
<th>Temp. (Time)</th>
<th>Shrinkages</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 1400°C (2 h)</td>
<td>60 - 65%</td>
</tr>
<tr>
<td>2 1200°C (8 h)</td>
<td>50 - 55%</td>
</tr>
<tr>
<td>3 1000°C (12 h)</td>
<td>45 - 50%</td>
</tr>
</tbody>
</table>

3. CONCLUSIONS

Porous Ni-Zn Ferrite ceramic had been successfully prepared by using wood templates. Sol gel method had been used to prepare the Ni, Zn, Fe nitrates. The single phase ferrite formed at higher temperature or longer sintering time. NiZn ferrite wood sintered at 1200°C for 8 h retained the shape and the microstructure as those of original raw wood with minimum cracks.

4. REFERENCES


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