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LOW-TEMPERATURE SPARK PLASMA SINTERING OF TRANSPARENT CERAMICS BY USING SiC MOLDING SET

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Hydroxyapatite (HAP) and alumina ceramics were sintered at low temperatures by using the SiC molding set during spark plasma sintering (SPS). Transparent ceramics were obtained at 800 °C and 1000 °C for HAP and alumina, respectively. The SiC is electrically conductive (3×10^4 S/m), so that the molding set (mold, punch and spacer) was directly heated during SPS without external heating. Compared to the conventional graphite molding set, the voltage level during heating was higher due to lower conductivity. When the graphite molding set was used, the temperature required for transparent HAP and alumina was about 950 °C and 1150 °C, respectively. The SiC molding set lowered the temperatures for transparent ceramics by 150 °C (Fig. 1). For transparent HAP, the transmission is almost similar between the samples sintered at 800 °C with the SiC set and at 950 °C with the graphite set. For transparent alumina, the transmission is considerably affected by the heating rate. At <20 °C/min, the transmission of the sintered alumina increases with an increase in the heating rate and shows a maximum at 20 °C/min. This is opposite to the behavior for the graphite molding set, where the transmission decreases with increasing heating rate. The dependence on the heating rate is explained by considering the effect of applied voltage during SPS. The high voltage level seems to enhance the diffusion during sintering. At a heating rate of 50 °C/min, the transmission of the alumina decreases due to the accelerated grain growth, and the delay behavior of dynamic grain growth was also observed. In this study, the effects of the SiC molding set were examined on the densification temperature, transmission, voltage level and grain growth.

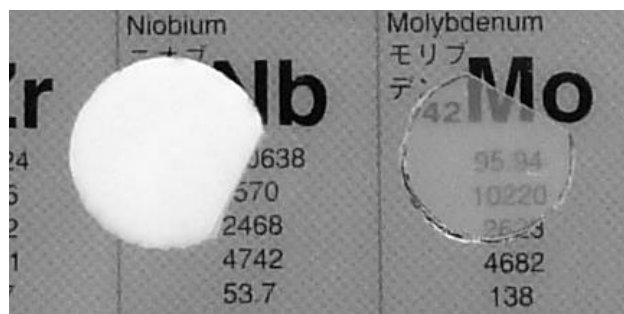


Figure 1 – HAP ceramics sintered at 800 °C for 10 min by using the graphite (left) and SiC (right) molding set. The 2.3 mm thick samples are 24 mm above the text.