# INVESTIGATION OF THE MONGOLIAN CLAY FOR THE PRODUCTION OF CERAMIC MEMBRANES

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## Abstract

Water conservation and water managment are an important issue, not only in Mongolia but also internationally. Therefore, scientists from the Institute of Materials Science of the Republic of Korea and the Center for Materials Science conducted a joint project between 2017-2020. As Mongolia is a developing country, it can be said that the chemical industry is almost non-existent. But it is a country rich in minerals. In this study, ceramic membrane supports with a compressive strength of up to 138.4 MPa were obtained using Mongolian clay raw materials such as Mandal-Ovoo kaolin and Ulaan nuur clay. The supports were extruded by a double screw vacuum extruder at Korean Institute of Material Science.

## Introduction

Mongolia has a very large area of 1.5 million square kilometers. But the water reserve is not much [1]. In addition, in Mongolia always use fresh water for the household as well as the industry. Water treatment i s not common. Only a few mining factories have wat er recycling. Ceramic membranes are high-quality pr oducts and offer several advantages over polymer m embranes [2]. The membrane processes are now wel l established, replacing the techniques of convention al separation. The supports of ceramic micro- and ult rafiltration membranes are extruded in order to reali ze the tubular geometry. Various oxide ceramics are used as the material, each of which is advantageous or disadvantageous for corresponding applications d ue to its physical and chemical properties [3-5]. Influencing the pore size of ceramic supports is the subject of numerous publications and should therefore not be discussed in depth at this point.

In addition to the pore size, the surface charge plays an important role in ceramic membranes. An alterna tive to optimizing ceramic membranes is the combin ation of ceramic and polymer membranes will gain in importance in the near future, as the Advantages of both membrane types combined in one product can be [6-7]. In addition to optimizing and improving cer amic membranes as isolated products, the optimal pl acement and combination of corresponding product s in increasingly complex process and production cha ins will also become increasingly important.

## Methods And Materials

Preliminary tests were carried out with the clay from Ulaan nuur, and we have determined that the compressive strength of the samples was 67 MPa. But the porosity decreased with the increasing burning temperatures. Also, the clay has shrunk after burning. To reduce the shrinkage, we prepared chamotte with the kaolin from Mandal-Ovoo and used them in the offsets. The prepared kaolin was ground and sieved with a 0.1 mm sieve. The sieved kaolin was treated thermally at 1000 °C for 1 h. After burning, the chamotte was ground with vibratory mills. The contingent of chamotte was 50%, 60%, 70%, 80%, and 90%. The samples were burned at 1000 °C, 1050 °C, 1100 °C and 1150 °C for 1 h. Samples were pressed dry with a 30t press. For the investigation of kaolin from Mandal-Ovoo and clay from Ulaan nuur, following analysis methods have been conducted: X-ray diffraction were recorded on X-ray diffractometer (XRD2200-Rigaku Japan) with Cu-Kα source operated with the wavelength at $\lambda = 1.5418$ Å Slit systems, step-size (0.02°), source voltage (40 kV), and current (30 mA) were kept constant during the scans that were conducted in θ–2θ coupled mode, and chemical analysis was carried out by the X-ray fluorescence analysis at the Korea Institute of Material Science (KIMS).

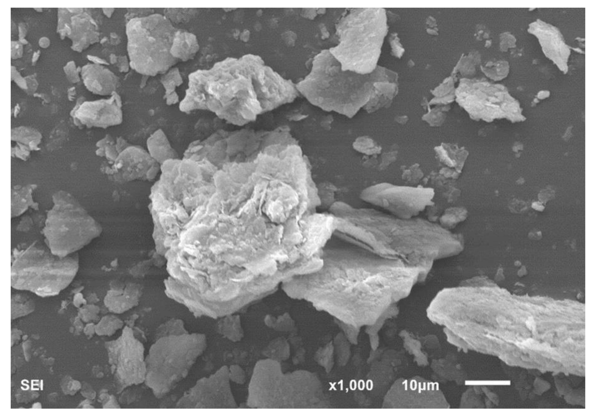

**Figure 1.** SEM of Mandal-Ovoo kaolin

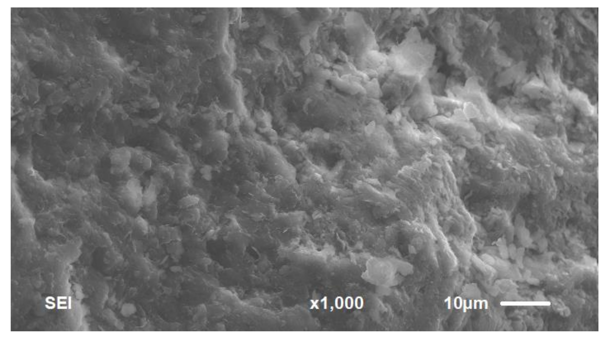

**Figure 2.** SEM of Ulaan nuur clay

## Results

Clay of Ulaan nuur contains $SiO_2$ – 63.8%, $Al_2O_3$ - 12.9%, $TiO_2$-0.47%, $CaO$-0.8%, $Fe_2O_3$ -1.97%, $K_2O$ – 1.41%, $Na_2O$ - 0.96% and $MgO$-0.4%. Although the clay of U had the highest compressive strength at 1100°C (67.9 MPa), it had the low water absorption (4.75%). This clay was porous itself. But after the burning sintered too much, so it was very fine pores and too compacted. The kaolin from Mandal-Ovoo was indeed sintered, but not as strong as the clay of Ulaan nuur. Because the kaolin contains over 20% $Al_2O_3$, the burning temperatures were higher and only compacted at 1200°C. In addition, the compressive strength at the temperature 1000°C was 46. That's why we made the chamotte from this kaolin. For the dry pressing of the samples, in addition to the clay, methyl cellulose and polyvinyl alcohol were used as binders. The binder methyl cellulose and polyvinyl alcohol were taken on dry mass 2.5% + 2.5% and 5% + 5%. The results from Figure 4 show that samples with 50% kaolin show the highest compressive strengths. This is due to the high content of binder clay. The results of water absorption show that water absorption decreases with increasing temperature. This shows that the sintering of the ceramic body is ongoing strongly. The results of the bulk density determination show that the density increases with the increase in the burning temperature and decreases with the increase in fire clay contingent. (Fig. 6) The water permeability of the samles was measured with fresh water.

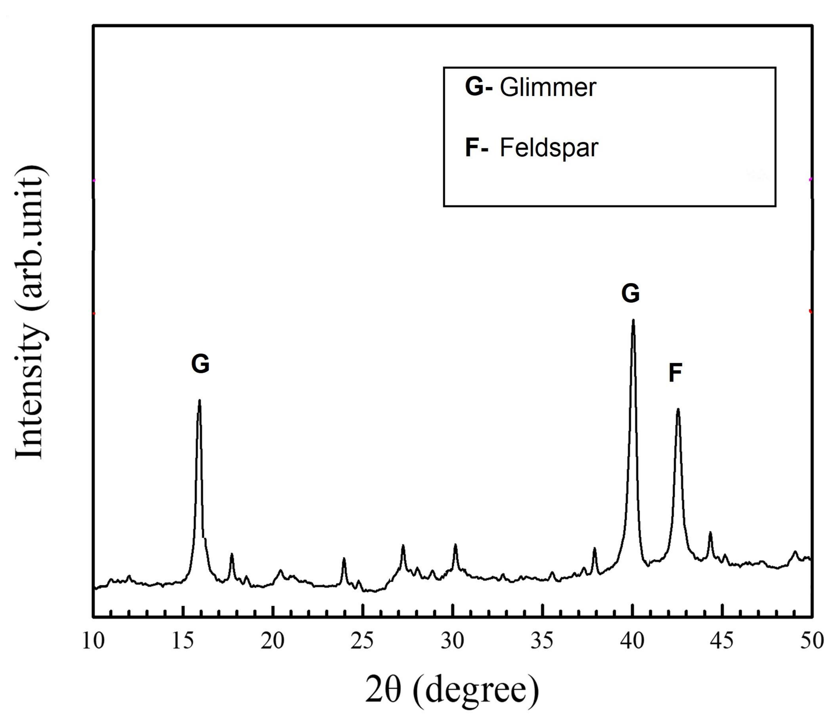


**Figure 3.** X-ray diffraction patterns of Ulaan nuur clay

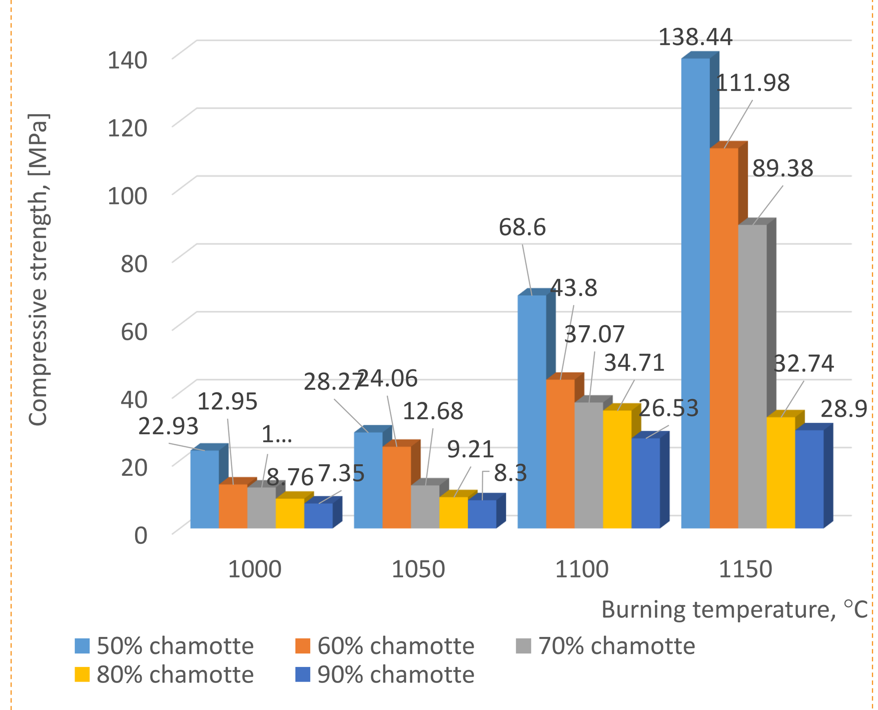


**Figure 4.** The Compressive strength of the samples, [MPa]

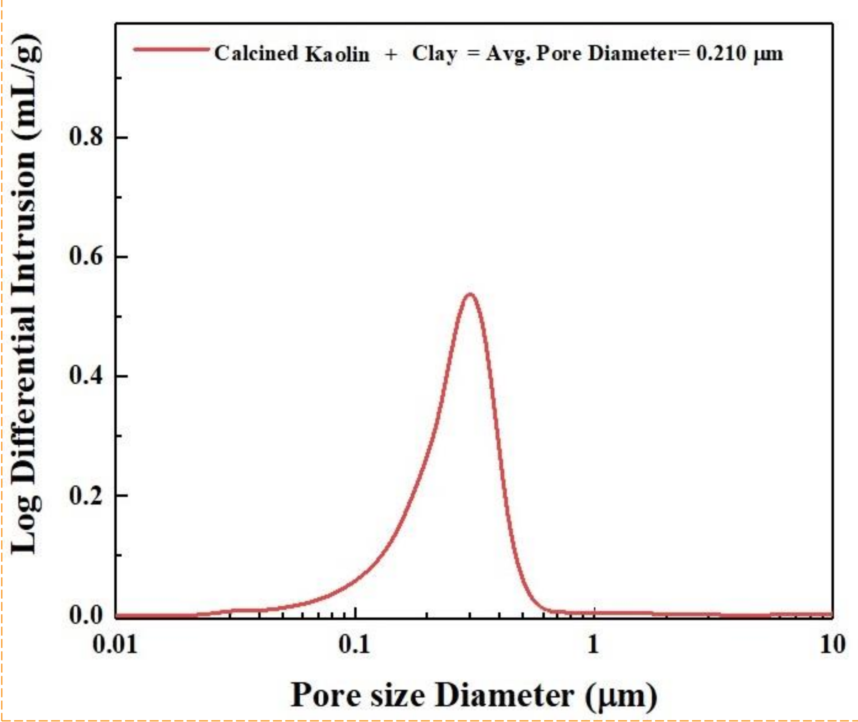


**Figure 5.** Pore size distribution of the support

## Discussion

The use of kaolin reduces the shrinkage of the supports. The results of the compressive strength show that the addition of kaolin increases the compressive strength.

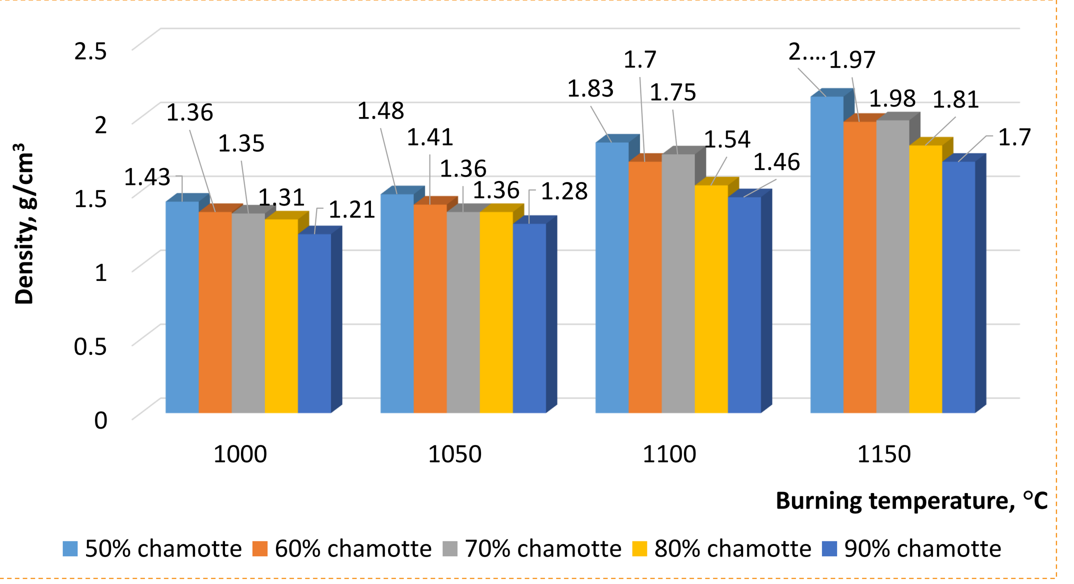


**Figure 6.** Bulk density of samples

## Conclusions

In this study, a ceramic membrane carrier was obtained using porous clay and chamotte. The supports have been burned at 1000 and 1150 °C 1 h and the properties such as compressive strength by press, density and pore distribution have been determined by mercury porosimeter. The samples with 50% kaolin were shown to have the highest compressive strengths such as 68.6 MPa at 1100 degrees Celsius and 138.44 MPa at 1150 degrees Celsius. The support with the highest compressive strength had a density of 2.14 g/cm$^3$, a porosity of 46.21% and, an average pore size of 210 nm. With its water permeability of 206.88 l/m$^2$·h at 0.01 MPa and 783.2 l/m$^2$·h at 0.08, the support achieved good results.

## Future Directions

This study shows that the Mongolian raw materials are conditionally suitable for ceramic membranes. Further research is needed to determine the optimal composition of the clay particles, to determine the optimal amount of additional kaolin, and to determine the optimal pore size distribution.

## Contact Information

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