Comparing the Chemical Characteristics of Geopolymers Formed Using Two Different Metakaolin Products

*Mika Yamada, Guodong Cai, and Hideo Komine
Waseda Univ.

Geopolymers (GPs) are formed by alkali reaction of metakaolin, which is the primary raw material. Metakaolins (MKs) are available commercially with a variation in mineralogical composition. This study investigates whether the variation in metakaolin composition has a significant impact on the chemical characteristics of the GPs formed from them.

Keywords: geopolymer; metakaolin; chemical characteristics.

1. Introduction

Generally, GPs take the primary raw materials such as MK, coal fly ash, and blast furnace slag synthesized by alkali reaction. However, in nuclear waste encapsulation applications, MK is of interest considering the chemical variation of the primary material. MK is manufactured through the calcination of kaolin and therefore provides different mineralogical composition products. We have investigated whether two different MK products result in different chemical and physical characteristics of the GPs.

2. Experimental

The alkali solutions used to blend with two different MK products (A and B) were potassium silicate solution and potassium hydroxide solution. The GPs were produced with SiO_2/Al_2O_3 = 3.5, K_2O/Al_2O_3 = 1, and H_2O/Al_2O_3 = 12, by hand mixing of the MK products and alkali solution, at 22 °C. The GP grouts were cast in a plastic mold (φ50×100 mm) and the lid was sealed with a parafilm strip. Curing was performed at 30 °C for 5 days and at 40 °C for 4 days following removal of the strip. Fourier transform infrared (FTIR) spectroscopy data and X-ray diffraction (XRD) data were obtained for MK-A, MK-B, GP-A and GP-B.

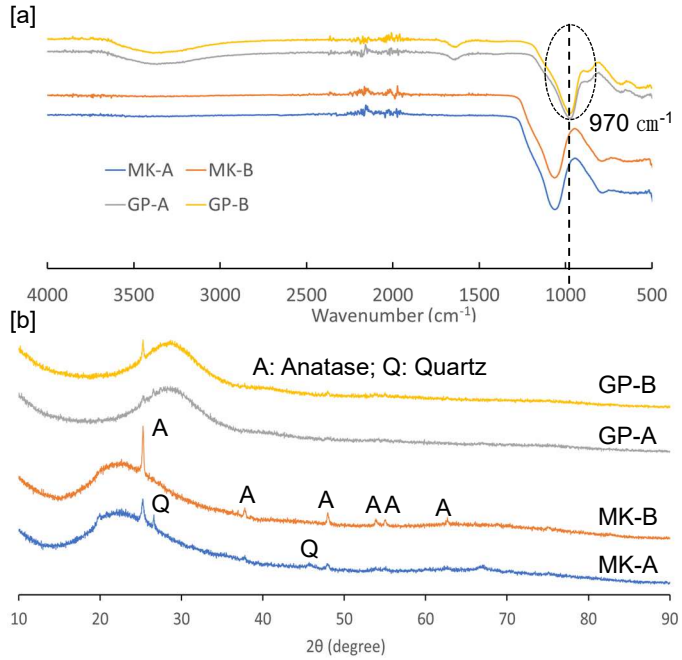

Fig. 1 FTIR spectra (a) and XRD data (b) for MK-A, MK-B, GP-A and GP-B

3. Results and discussion

For GP-A and GP-B spectra (Fig. 1a), the high intensity band at 1000 cm^{-1} with towered lower wavenumbers are consistent with the formation of potassium aluminosilicate hydrate gel. There is no significant difference in the bands comparing GP-A and GP-B. Reflections assigned to anatase and quartz are visible in the XRD data (Fig. 1b) for MK-A and GP-A. Only anatase is visible for MK-B and GP-B. In GP-B only, a crack on the upper surface was observed after the curing period. Uniaxial compressive strength (UCS) of GP-B also results in a lower value than of GP-A. The XRD visible quartz in MK-A may slow the rate of the dehydration condensation reaction to form the GP, thus it may cause the different appearance and UCS of GP-B.

4. Conclusions

Two different MK products were used to compare the chemical characteristics of the GPs formed from them. Further studies are needed to understand how the curing process is affected by different MK compositions, and to enable GPs to be formed that are suitable for intended applications.