

Characterization of Heat Activated Minerals from Puturge (Malatya, Turkey)

E. Izcı

Physics Department / Anadolu University, Eskisehir, Turkey.

The samples were obtained from CimSa Mining Company operating industrial mineral deposits in Puturge- Malatya, Turkey. They were crushed, ground, and sieved to pass through a ≤ 63 μm sieved. The samples were heated at 400, 600, and 950 $^{\circ}\text{C}$ for 3 h in air and then cooled to room temperature. Both the heating rates were 5.3 $^{\circ}\text{C}/\text{min}$. Then they labeled as P400, P600, and P950.

Rigaku Rint 2200 powder diffractometer with Cu $K\alpha$ radiation was employed for XRD measurements. Infrared spectra of the unheated sample (P sample) and the heated samples (P400, P600, and P950) were recorded (1400- 400 cm^{-1}) with Bruker Optics IFS66v/s FT-IR spectrometer at a resolution of 2 cm^{-1} at room temperature.

Figure 1 shows X-Ray diffraction patterns of the unheated sample (P sample) and sample P950. The major phase is quartz (Q) with additional mineral phases of pyrophyllite (P), kaolinite (K), muscovite (M), and paragonite (Pr) in minor quantity. Presence of peak values at d (nm) 0.4231, 0.3333, 0.2450, 0.2227, 0.2230, 0.2122, 0.1977, 0.1932, 0.1815, 0.1669, 0.1540, and 0.1381 may be an indicative of the presence of quartz. Similarly the peak values at d (nm) 0.973, 0.3199, and 0.2555 indicate the presence of muscovite. Unlike these, the peak values d (nm) 0.362, 0.236, and 0.112 show the phase of kaolinite and the peak values at d (nm) 0.654, 0.3645, 0.235, and 0.163 show the phase of pyrophyllite. Also, the peak values at d (nm) 0.362, and 0.2628 show paragonite that is a type of mica such as muscovite. In the track of XRD of sample P950, new phases that cannot be seen in the sample P occurred. One of these phases is illite. The reason why kaolinite phase in the P sample is not seen in this P950 phase is that metakaolinite phase occurs [1]. Also, muscovite is a member of mica mineral group and its phase changes start when heat processes at 800-1000 $^{\circ}\text{C}$ are applied [2]. The reason why potassium mica phase is seen in the track of XRD of the sample P950 may be this crystal structure change.

FT-IR spectrum of P, P400, and P600 samples is shown in the Figure 2. For the sample P, the peak at 1121.49 cm^{-1} is an Al- OH stretching vibration [3] and the peak at 1071.43 cm^{-1} is the Si-O stretching vibration peak [4]. The peak at 1054.98 cm^{-1} corresponds to the intense Si-O and Si-O-Al stretching frequencies, characteristic of aluminosilicates [3] and the peak at 952.72 cm^{-1} is the peak of Al-OH or Si-OH [3, 5]. Furthermore, the peak at 801.36 and 841.87 cm^{-1} result from the vibration of Al-O and Si-O out of surface [4, 6]. The peak at 781.11 cm^{-1} is the Si-O stretching peak [3]. The peak at 542.55 cm^{-1} results from the bending vibrations of Al-OH. The band at 696.25 cm^{-1} is due to the deformation and bending modes of the Si-O bond. Since there is no new formation, P400 and the sample P have the same phases and peaks. However, in the P400 sample, with the temperature increase for the heat application, water peaks start to move away from the structure [7] and the intensity of the Al-OH peak at 1121.49 cm^{-1} decrease. It is not seen in the P600. At sample P600, there is also a change in the absorption band at 541.95 cm^{-1} . It is attributed to Si- O- Al bands. That change is related to the distortion of the silicate framework and it is specific for certain minerals [3]. In addition, four new absorption bands appeared at 865.01, 735.79, 654.79, 567.71 and 437.81 cm^{-1} at 600 $^{\circ}\text{C}$. These peaks are the small peaks. When heated at 950 $^{\circ}\text{C}$, the intensities of the 735.79, 695.54, 654.78, 486.02, 437.81, 422.38, and 408.88 cm^{-1} band increased. At this temperature, the peaks at 1087.78, 867.62, 782.08, and 488.92 cm^{-1} appear and

these new peaks are Si- O- (Al, Mg, Fe possibly) The two bands at 567.03 cm^{-1} and 488.92 cm^{-1} assigned to Si-O bending vibration [6, 7]. In addition, the peak at 1125.38 cm^{-1} disappears (Figure 3).

References:

[1] AGS Cristobal *et al*, Materials Research Bulletin **44** (2009) p. 2103.
 [2] F Gridi-Bennadji *et al*, Applied Clay Science **38** (2008) p. 259, 260.
 [3] TK Mukhopadhyay, S Ghatak, and HS Maiti, Ceramics International **36** (2010) p. 913.
 [4] C De-guang and SU Da-gen, Journal of Chongqing University **4** (2005) p. 72.
 [5] M Erdemoglu *et al*, Applied Clay Science **27** (2004), p. 45.
 [6] P Padmaja *et al*, International Journal of Inorganic Materials **3** (2001), p. 695, 696.
 [7] T Jiang *et al*, Applied Clay Science **40** (2008), p. 85.

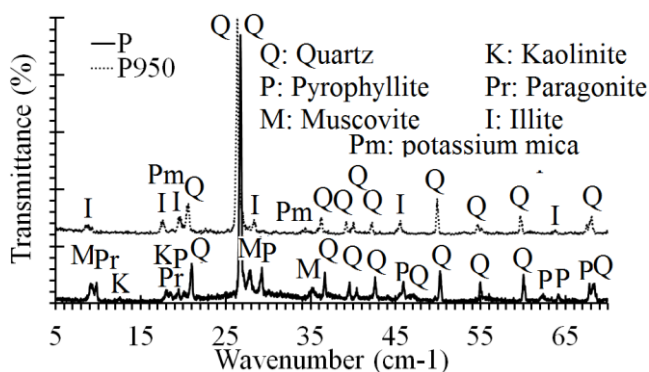


Figure 1. XRD patterns of the P and P950 samples

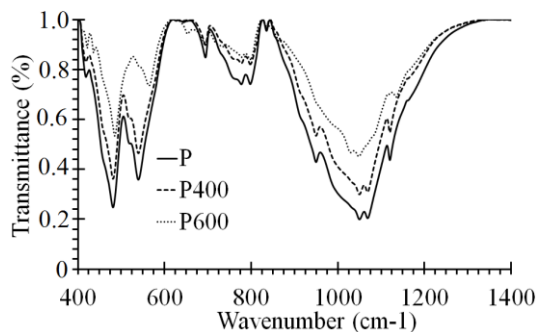


Figure 2. FTIR spectra of the P, P400, and P600 samples

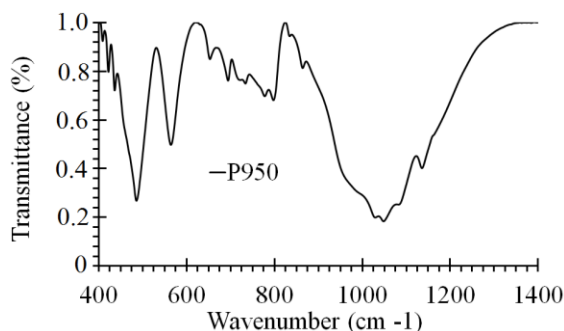


Figure 3. FTIR spectrum of the P950 sample