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HIGH TEMPERATURE SOLID STATE TRANSFORMATIONS IN JAMMU BAUXITE

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Thermal reactions of Jammu bauxite heated to different temperatures from 950°–1900°C were studied by X-ray powder diffraction method. The formation of mullite by the alumina-silica reaction at temperature 1200°–1400°C and then the transformation of mullite to a glassy phase around 1900°C has also been discussed in detail.

Keywords: bauxite, high temperature solid state transformation

Introduction

Wahl, Grim and Graf [1] examined the reaction between various crystalline forms of alumina and silica. According to Brindley and Choe [2] all alumina hydrates when heated to sufficiently high temperatures from corrundum but the reaction sequence vary considerably. Brindley and Nakahira [3] have put forward a reaction series for the decomposition of kaolin.

The Jammu bauxite had been the subject of numerous investigators [4, 5] but its high temperature reactions have not been reported so far. In the present investigation samples have been studied upto 1900°C and attempts have been made to separate the product into different functions.

Experimental

Representative samples were powdered, sieved through 200 B.S.S. mesh and heated to elevated temperatures upto 1900°C in different furnaces. The sample

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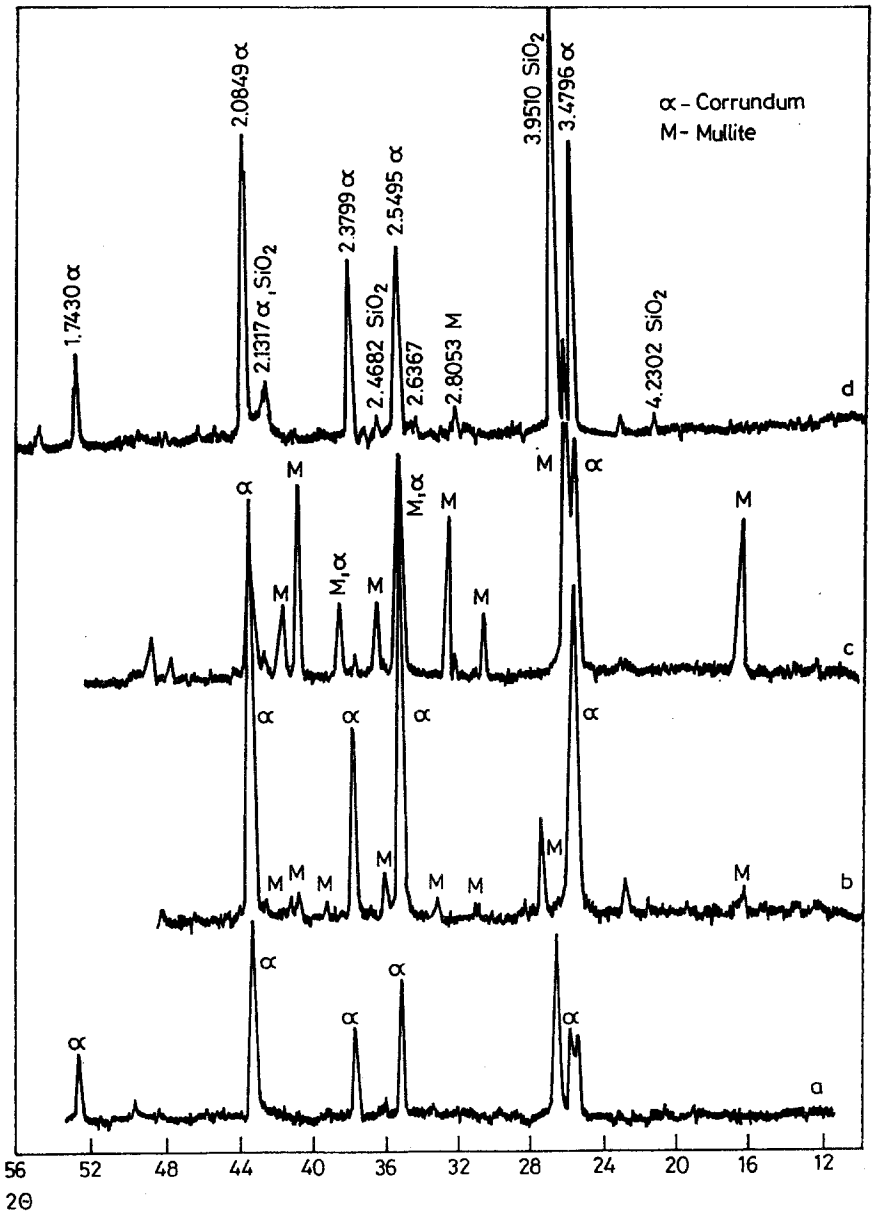

Fig. 1 X-ray powder diffractograms of the samples:
a – Sample heated at temperature 950°C, b – Sample heated at temperature 1200°C,
c – Sample heated at temperature 1400°C, d – Sample heated at temperature 1900°C

fused at 1900°C was separated into different fractions with the help of bromoform. The lighter particles remaining in the suspension were separated,

dried and assigned as number 1 sample. The three distinct layers of the settled particles thus obtained were separated. The top layer was numbered as number 2 sample, the middle one as number 3 whereas the bottom layer was named as number 4. The X-ray analysis of the various fractions and the original sample was carried out using Philips P.W. 1050 powder diffractometer using CuK_α radiation (30 kV and 15 mA). The chart drive and scanning speed of the goniometer were maintained 1 cm/min and 1° in (2θ)/min, respectively.

Results and discussion

Figure 1 (a, b, c) represents the X-ray diffractograms of the samples heated at 950°, 1200° and 1400°C respectively. The samples were heated in a muffle furnace for 1 h at each stage of heat treatment with a temperature variation of ±5°C.

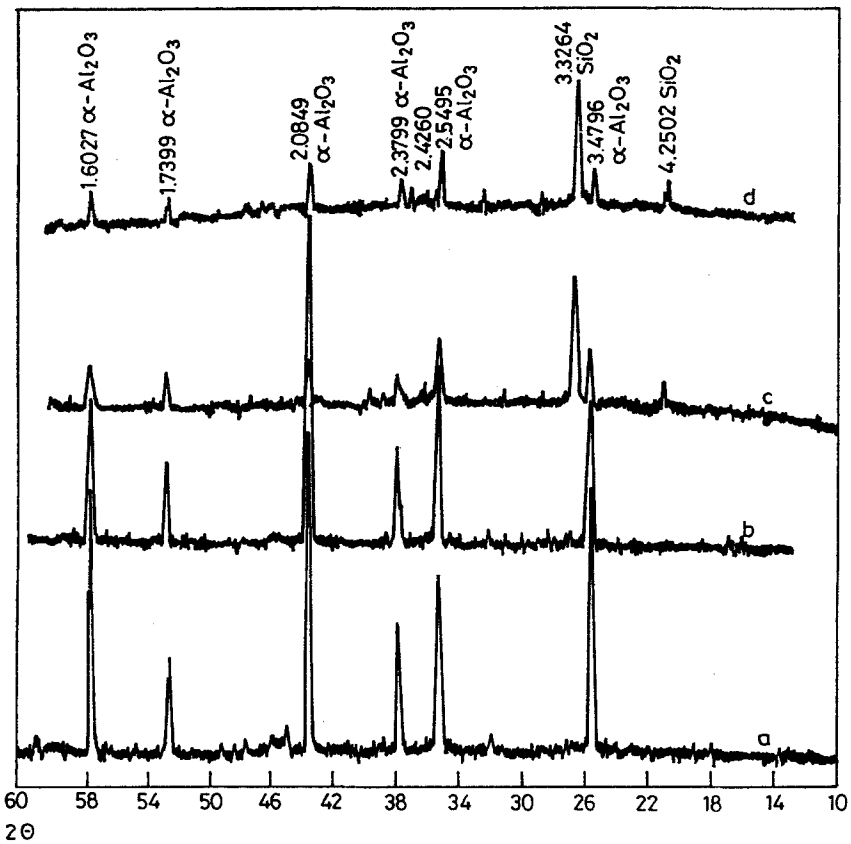

Fig. 2 X-ray diffractograms of the samples, (heated at temperature 1900°C) separated into different fractions using bromoform.
a – sample 4; b – sample 3, c – sample 2; d – sample 1

The interplaner spacings and peak in tensities, calculated from the diffractograms, were compared with standard ASTM data cards. The X-ray analysis revealed that fired material (a mixture of kaolinite, boehmite and diaspore) has transformed to a mixture of α-Al_2O_3 and A--Si spinel at 950°C, mullite, α-Al_2O_3 and SiO_2 at temperature 1200°C.

At 1400°C the (011), (112) reflections of mullite phase have become sharp and distinct in intensity whereas the intensity of (113) spacing of corrundum has decreased. This increase in the concentration of mullite is due to the silica alumina reaction as the corrundum during its formation from boehmite is likely to be in a reactive state [6]. At this temperature the presence of α-Al_2O_3 can be attributed to the stable form of corrundum derived from diaspore [7].

Figure 1d represents the X-ray diffractogram of the sample heated at 1900°C. It is clear from the diagram that in addition to α-Al_2O_3, silica lines have also appeared whereas mullite phase has disappeared altogether. This may be conjectured that mullite phase has decomposed giving rise to free silica and alpha alumina. Figure 2 (a, b, c, d) represents the X-ray diffractogram of sample number 4, 3, 2 and 1 respectively obtained by separating the product at 1900°C into different fractions. The diffractograms of sample 3 and 4 show α-Al_2O_3 in predominant concentration whereas the diffractogram of sample 1 shown in Fig. 2d, shows predominantly silica and very little of α-Al_2O_3.

This is because the denser particles of corrundum settle down more rapidly than the lighter silica ones which remain in the suspension.

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Zusammenfassung — Mittels Pulverdiffraktionsverfahren wurden die thermischen Reaktionen von Jammu-Bauxit beim Erhitzen auf verschiedene Temperaturen zwischen 950° und 1900°C untersucht. Die Bildung von Mullit durch die Aluminiumoxid-Siliziumoxid-Reaktion bei der Temperatur 1200°-1400°C und dann die Umwandlung von Mullit in eine Glasphase bei 1900°C wurde ebenfalls detailliert diskutiert.