Applied Clay Science 108 (2015) 135–143

Contents lists available at ScienceDirect

Applied Clay Science

journal homepage: www.elsevier.com/locate/clay

Research paper

Assessment of clays from Puertollano (Spain) for their use in fine ceramic by diffuse reflectance spectroscopy

M.C. Zurita Ares [a], M.R. Pérez [b], L. Quesada Carballo [a], J.M. Fernández [a,b,*]

[a] Department of Inorganic Chemistry and Chemical Engineering, E.P.S. of Belmez, University of Córdoba, E14240, Spain
[b] Department of Inorganic Chemistry and Chemical Engineering, Faculty of Sciences, University of Córdoba, E14071, Spain

ARTICLE INFO

Article history:
Received 18 July 2014
Received in revised form 30 January 2015
Accepted 2 February 2015
Available online 27 February 2015

Keywords:
White clay
Second derivative
Kubelka–Munk function
Diffuse reflectance spectroscopy

ABSTRACT

Four different samples of sterile waste clays resulting from the coal mining activity in Puertollano (Ciudad Real, Spain) have been assessed for their potential use in the ceramic industry. Raw and calcined samples have been characterized by atomic absorption, X-Ray diffraction, scanning electron microscopy and second derivative of the diffuse reflectance spectra. This last measurement allowed not only the detection but also the quantification of the amounts of hematite and goethite responsible for the reddish color. This method proved to be the most accurate and successful in the determination of the samples' composition. Particularly, one of the clay samples was found to be suitable for its use in the fine ceramic industry, whereas other clay samples could be utilized in the production of bricks or as reddish pigments.

1. Introduction

Nowadays, ceramics are being widely used in many fields, with building and decoration among the most important industries. For this reason, the manufacture of high-quality ceramics at the lowest possible price becomes an issue of prime importance. In the current competitive international market, a ceramic white body is considered to be of higher quality than those presenting a colored body. Therefore, it can be sold at higher prices, thus allowing companies to obtain larger benefits. Since the raw material of ceramics is clay, those resulting in white ceramic are the most valuable ones (Barrachina Albert, 2011).

Ceramic products can be classified according by their final color (colored or white products) and firing temperature: colored structural ceramic (850 °C–1100 °C), white firing products (1100 °C–1250 °C) and refractory ceramic (>1450 °C). The clays used for obtaining these products are reddish clays, white clays (that is, kaolinitic clays) and refractory clays, respectively (Galán Huertos and Aparicio Fernández, 2006).

Spain is one of the main producers of ceramics with a wide range of uses. In Spain, due to the existence of clay deposits with a high content of iron oxides close to the largest ceramic industrial area (Castellón), the highest percentage of production (ca. 90%) corresponds to red firing products. In recent years, a significant growth in the manufacture of white body tiles has occurred because of the reasons mentioned above (Barba et al., 1997).

One way to producing white firing clays at low cost would be reusing some of the clays from other sterile mining. This may be the case of coal mines where clays such as lutites can be found in different coal layers (Parras et al., 1996). The production of sterile mining in coal mining is high and useless. Consequently, it would be of a great economic interest to characterize clays from this sterile mining for their potential use in the ceramic industry. In this sense, Parras et al. (1996) made a preliminary study of the possible application in ceramic of the waste generated in coal mining. They concluded that these raw materials are suitable for their utilization in the ceramic tile industry for producing white or lightly colored ceramics. Indeed, the composition of the raw material will determine the final color of the manufactured ceramic material. Gámiz et al. (2005) related the chemical–mineralogical composition to the color properties, and Gonçalves et al. (2012) employed diffuse reflectance to analyze the final color of the material, which depends on whether the iron is present either in the form of oxides and oxyhydroxides or silicates.

The diffuse reflectance spectrum of each sample depends on the different components present in the sample. In fact, by inspecting the spectral shape, the specific component contributing to a particular color can be identified (Fernández-Rodríguez and Fernández-Fernández, 2005; Zurita Ares et al., 2014). Each sample has a characteristic curve that depends on its color. This fact allows the use of a reflectance spectrum to quantify individual compounds present in the sample (Tłaczała and Bartecki, 1995; Lacombe et al., 2001; Bondioli et al., 2006; Middleton et al., 2011; Song et al., 2012).

* Corresponding author at: Dpto. Química Inorgánica e Ingeniería Química, Campus de Rabanales, Universidad de Córdoba, Córdoba E14071, Spain. Tel.: +34 957 218648; fax: +34 957218621.
E-mail address: um1feroj@uco.es (J.M. Fernández).

http://dx.doi.org/10.1016/j.clay.2015.02.010
0169-1317/