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Note

# The preparation of micro-porous membrane from a Tunisian kaolin

I. Hedfi [a,*], N. Hamdi [a], E. Srasra [a], M.A. Rodríguez [b]

[a] Centre National des Recherches en Science des Matériaux, BorjCedria Techno-Park, B.P. 95-2050, Hammam Lif, Tunis, Tunisia
[b] Instituto de Ceramica y Vidrio, CSIC, c/kelsen, 5, 2849 Madrid, Spain

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ABSTRACT

The purpose of this work is the preparation of a low cost membrane from Tunisian kaolin in order to be used in a filtration process. This study has begun with the characterization of the raw material in order to choose the best condition of the membrane preparation. After the clay characterization, it has been pressed and sintered at 950 °C for 2 h to obtain the flat ceramic membranes of 25 mm in diameter. Different characterizations were performed to determine the porosity, the density and the mechanical strength of these membranes; samples show good porosity (~30%), high compressive strength, around 60 MPa, but relatively low permeability.



## 1. Introduction

Kaolinite consists of dioctahedral 1:1 layer structures and its particles have about 50 silicate layers. The layers are bonded together by Van der Waals forces and hydrogen bonds (Rao et al., 2011). Kaolin is one of the most widely used industrial minerals; it has an important role in numerous industrial applications, such as ceramics, paints, cosmetics, rubber, plastic, and refractory industries (White et al., 2009; AL-Shameri and Lei, 2009). The diversified industrial uses of kaolin are ruled by specific properties for each technological use. Properties depend on the geological conditions under which the deposits were formed (Knill, 1978; Murray and Keller, 1993; Ekosse, 2000; Cravero et al., 1997, 2001; Nyakairu et al., 2001), their mineralogical and chemical compositions, their crystal order (Cases et al., 1986; Martin, 1994; Pinheiro et al., 2005), and their physical properties, color and firing characteristics (Bloodworth et al., 1993; Gámiz et al., 2005; Siddiqui et al., 2005). Kaolin is still a preferred raw material for porous ceramics (Ganesh and Ferreira, 2009).

In the last decade, porous ceramics has attracted increasing attention for its successful application in many industry areas, such as supports for catalysts and membranes (Ismagilov et al., 1997). The ceramic membranes are very competitive in terms of mechanical, chemical and thermal resistance; these membranes have gained, in recent years, an important place in chemical technology being in a broad range of applications (Brites Alves et al., 2000; Molinari et al., 2002). The development of clay-based inorganic membranes could lead to an important new technological application that would add economic value to the used of the membrane processes in the environment (Khemakhem and Ben amar, 2012).

In this study a Tunisian Kaolin was characterized in order to be used on the preparation of low cost ceramic porous membranes useful for many applications such as microfiltration or as a support of ultra and nanofiltration.

## 2. Experimental procedure

### 2.1. Raw material characterization

In this study kaolin, extracted from the region of Tabarka located on the north west of Tunisia, has been used.

#### 2.1.1. Chemical analysis

In order to define the composition of the clay the sample has been dissolved with three strong acids (HCl, $H_2SO_4$, $HNO_3$) in the following proportions 3:1:1 respectively. The mixture was heated in a sand bath until everything goes into solution except the silica. It was removed by filtration and dried and the silica content was then determined gravimetrically. $Al^{3+}$ cations, $Fe^{3+}$, $Mg^{2+}$ and $Ca^{2+}$ were determined by atomic absorption. The loss of ignition at 1100 °C (LOI) was also performed.

#### 2.1.2. X-ray diffraction

To determine the mineralogical composition X-ray diffraction of the sample of clay used in this study was performed with Pan analytical X'pert High Score Plus diffractometer (UK) equipped with a Cu anticathode.

* Corresponding author. Tel.: +216 34697390874.
*E-mail address:* imen_hedfi@yahoo.fr (I. Hedfi).

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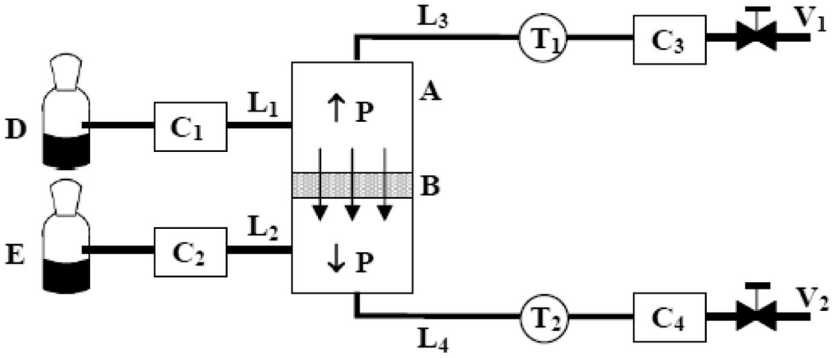


**Fig. 1.** A — membrane module, B — membrane, C1, C2, C3 and C4 — flowmeters, T1 and T2 — pressure transducers, D and E — bales of nitrogen, L1 and L2 — input lines, L3 and L4 — output lines, V1 and V2 — outlet valves.

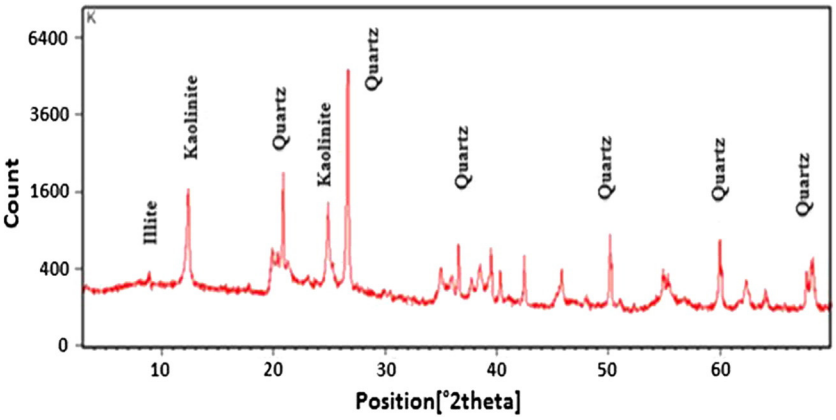


**Fig. 2.** X-ray diffraction of the clay sample, describing the patterns corresponding to the main phases.

*2.1.3. Dilatometry*

The dilatometric study of clay samples allows us to evaluate the sinterability of powders and follow the reaction phenomena from dilatometric curves. Then can be defined the optimal sintering conditions (temperature, atmosphere, bearing). Measurements were made using a dilatometer SETSYS 16/18 (Setaram, France) in air. The sample was prepared by pressing (51 MPa) in order to prepare a disk with 1 cm as diameter and 13 mm in height. It was heated to 1350 °C with a rate of 10 °C/min.

*2.1.4. Thermal gravimetric and differential DTA–TGA*

To carry out the study by thermal gravimetric and differential DTA–TGA, a mass of 70 mg of the sample was reduced by grinding to a

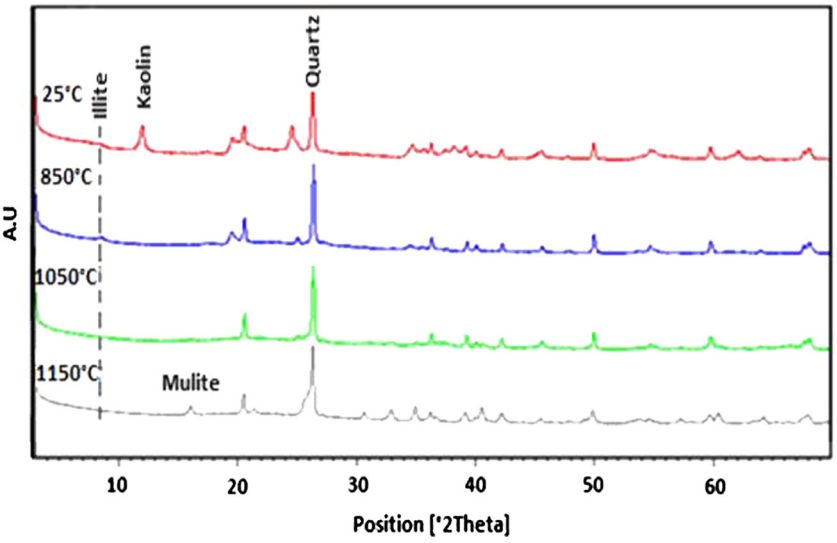


**Fig. 3.** X-ray diffraction for clay heated at different temperatures.

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