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Preparation and characterization of polymeric plasticized membranes (PPM) embedding a crown ether carrier application to copper ions transport

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Abstract

Polymeric plasticized membranes (PPM) are a new perspective to solve the stability problems of supported liquid membranes to perform the simultaneous separation, concentration and purification of valuable species from aqueous solutions.

Cellulose triacetate (CTA) membranes containing the crown ether dibenzo-18-crown-6 (DB18C6) as a fixed carrier were prepared and their performance tested for the transport of copper(II) ions. This study showed that PPM properties were influenced by the membrane composition. The transport studies revealed that diffusion rate was dependent on film thickness, the presence of a plasticizer, 2-nitrophenyloctylether, which plays also a critical role on the membrane physical characteristics (especially malleability) and the quantity of fixed crown ether. Porosimetry analyses showed conversely to other works with different carriers that all the membranes prepared are not porous for all membrane compositions. However, SEM analysis revealed a porous texture when the quantity of crown ether is higher than that of CTA. FTIR, X-ray and TGA characterizations showed that all the constituents of the membrane remain unaltered within the membrane without chemical interactions between them (no presence of new bonds in the FTIR spectra). Hence, transport mechanism of the copper(II) ions seems to be a jumping from site to site.

Keywords: Elaboration; Characterization; Polymer plasticized membranes; Copper transport

1. Introduction

Facilitated transport through liquid membranes is an attractive method for simultaneous separation, concentration and purification of species of interest from aqueous systems but it suffers from several technological problems such as membrane instability and leaching of the membrane components into aqueous phases [1–3]. In an effort to overcome these problems, a number of research groups with an interest in metal cation separation have investigated plasticized polymeric membranes [4–7]. These consist in fixing the carrier on the matrix of a polymer. In particular, the utilization of CTA as the membrane material has been recommended [8–11] due to its high hydrolytic stability and great resistance to biodegradation.

Polymer membranes made of CTA with grafted crown ether groups have been reported by Flyes et al. [12], Elliott et al. [4] and Thunhorst et al. [7]. Fixed Sites Membranes were used for transport of saccharides or amino acids through CTA membranes containing a lipophilic ammonium salt (trioctylmethyl-ammonium chloride TOMAC) as carrier [5,11]. Mediated carrier diffusion in CTA membranes was observed for potassium cation transport with dicyclohexyl-18-crown-6 as carrier [6]. Comparison of carrier-facilitated copper(II) ions transport mechanisms in a supported liquid membrane and in a plasticized CTA membrane has been reported

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by Paugam and Buffle [13]. New CTA membranes containing some macrocyclic polyethers as fixed carriers were prepared and applied for facilitated transport of copper(II), silver(I) and gold(III) metal cations in our earlier paper [14]. However, membrane preparations asked for more comprehensive investigations of the factors controlling the membrane properties such as membrane composition. This is the aim of the present paper.

2. Experimental part

2.1. Chemicals

Copper(II) Sulphate, Chloroform, CTA and 2-Nitrophenyl Octyl Ether (2NPOE) were analytical grade reagents purchased from Fluka. The carrier dibenzo-18-crown-6 (DB18C6) was a product of Aldrich. The reagent for copper analysis was used as kits purchased from Carlo Erba

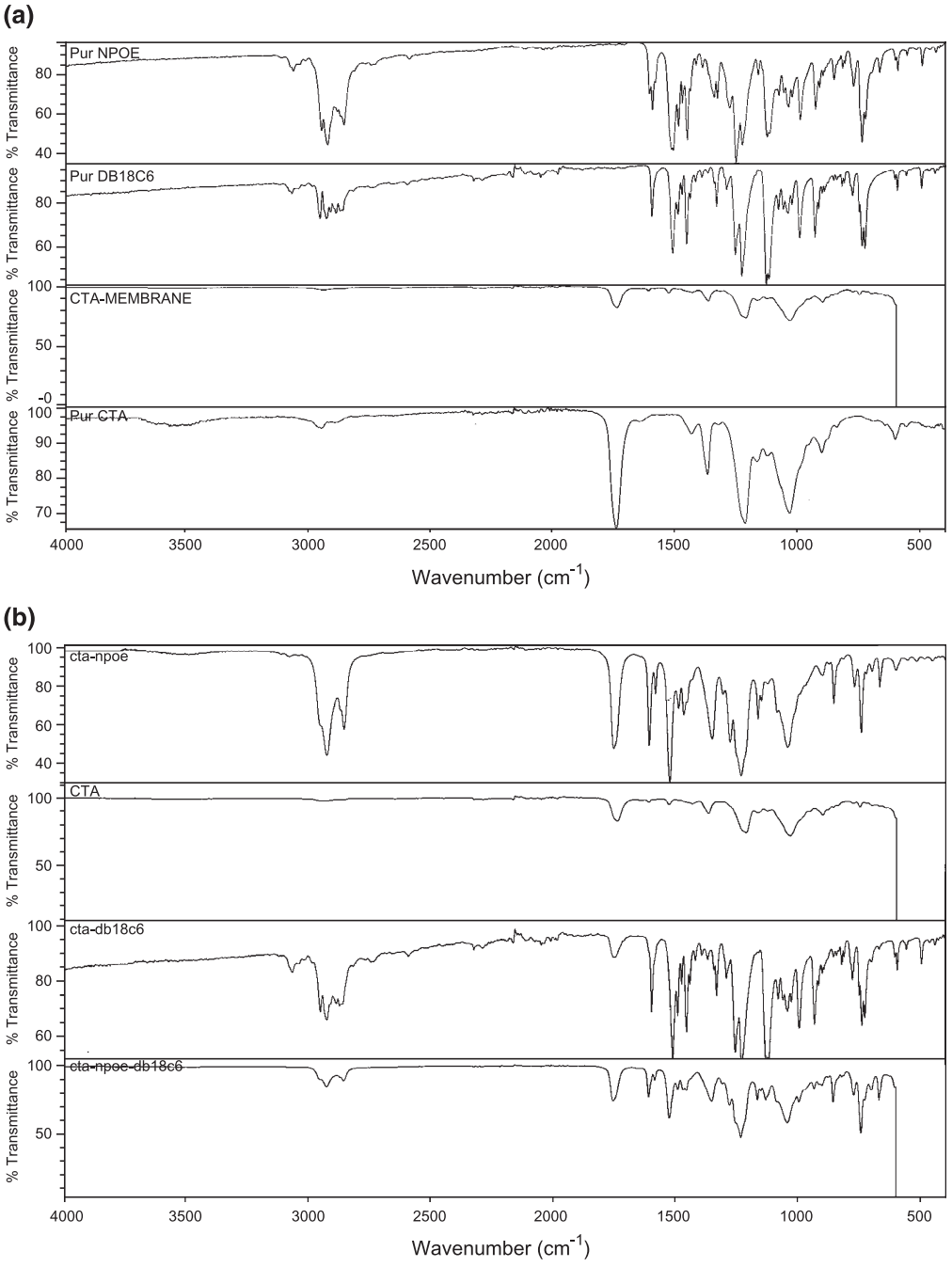

Fig. 1. FTIR spectra of (a) the different membrane constituents and (b) membranes.