EFFECT OF ORGANIC ACIDS ON THE FORMATIONS OF SILICA NANOMETERIALS

INTRODUCTION

The discovery of carbon nanotubes in 1991 (Iijima, 1991) has stimulated scientists to focus their attention on novel porous material (Kresge *et al*., 1992 and Huo *et al*., 1994) and nanosized tubular materials (Reskar *et al*., 1996, Zelenski *et al*., 1998 and Hacohen *et al*., 2002). Since then significant progress has been made in synthesizing other inorganic nanotubes and investigating their applications. The inorganic nanotubes display their potential applications for electronic devices, advanced catalysis, optical devices and separation materials (Lee et al. 2002, Mitchell *et al*., 2002 and Banerjee and Wong, 2002). Silica nanotubes are of special interest among oxide nanotubes because of their hydrophilic nature and surface fuctionalization. Many synthetic methods have been developed to prepare various nanotubes, such as, sol-gel method (Kovtyukhova *et al*., 2003), template assisted method (Kleitz *et al*., 2001, Hoyer, 1996, Martin, 1996, Krumeich *et al*., 2004, Obare *et al*., 2001, Jung *et al*., 2002, Steinhart *et al*., 2002, Zhang *et al*., 2002, Yin *et al*., 2002, Moon *et al*., 2003 and Yang *et al*., 2003) and surfactant mediated technique (Wang *et al*., 2000).

Silica nanotube materials are normally prepared by sol-gel method in the presence of a template. The template materials have been used so far include porous or solid rod-like materials e.g. carbon nanotube (Satishkumar *et al*., 1997), nanoporous film (Lakshmi *et al*., 1997) and organic molecules (Wang *et al*., 2001 and Mokoena *et al*., 2003). Porous or fibrous materials are used in the "direct" template method, where they act as guides to the formation of nanotubes. In the case of organic molecules, they can act to bring about

interaction and/or self-assembly between inorganic precursors and organic templates and offer an alternative method in the formation of inorganic nanotube materials. Organic templates that have been used for silica nanotube formation are long chain surfactants (Adachi *et al*., 1999 and Muhr *et al*., 2000), organogelators (Ono *et al*., 1998, Clavier *et al*., 2000 and Kobayashi et al., 2000) and organic carboxylic acid (Nakamura and Matsui, 1995a, 1995b, Miyaji *et al*., 1999, Sudheendra and Raju, 1999, Wang *et al*., 2001 and Mokoena *et al*., 2003). Long chain acids such as octanoic acid, decanoic acid and lauric acid were used as fibrous templates. Only citric and tartaric acid were used as dicarboxylic acid template. Both acids contain hydroxyl and carboxyl groups. In this study the effect of different carboxylic acids on the formation of silica nanotubes are compared. It was found that static or agitating condition also play a role on nanotube formation. The types of agitation may affect the nanotube formation. Thus the effect of stirring and shaking will be studied.

Objectives

1. Syntheses of the silica nanomaterials by template assisted method.
2. Study of the effect of different dicarboxylic acids acting as template on the formation of silica nanotubes.
3. Comparison of the silica materials which are obtained under stirring and shaking conditions.