CHAPTER I
INTRODUCTION

Porous materials are described as solid materials, containing pores. Porous materials have been used in various applications e.g. filter, catalyst support, packing materials for chromatography column, sensor, thermal insulator, selective absorbent, and electrode. They can be made from several types of materials, such as polymers, metals, glass, and ceramics. Porous materials made of polymer are one of the most popular due to their high strength to weight ratio, high machinability, high production rate, high property controllability, and low cost (Ishizaki *et al.*, 1998). There are two types of the most attractive porous polymeric materials in which we are interested. Those are polymeric foam and polymeric aerogel.

Aerogel is a porous material derived from a gel in which the liquid component is replaced with gas. The result is an extremely low-density solid with several remarkable properties, which the two most attractive ones are its extremely light weight and excellent thermal insulation. The morphology of aerogel can be modified by using different synthesis parameters. This characteristic makes the aerogel particularly well adapted for various applications, such as fuel cell, host material of catalysts, thermal insulator, and molecular sieve. Carbon aerogel, a novel form of aerogel, was first produced by Pekala *et al.* (1989). Organic and carbon aerogel processing have been widely developed to simplify the process. The traditional process for organic aerogel preparation normally used resorcinol (R) and formaldehyde (F) as the precursors. The RF aerogel consists of a highly crosslinked aromatic polymer. To obtain carbon aerogel, the RF gel is carbonized in an inert atmosphere. Basically, the crosslink density of the organic gel is a key parameter that needs to be considered for aerogel applications. Highly crosslinked organic gel not only provides high structural stability to preserve its structure after solvent removal, but also introduces high char yield after pyrolysis to construct the carbon aerogel. To find a reactant to synthesize the organic aerogel and transform it into carbon aerogel, these two characteristics of the synthesized gel need to be considered. Since benzoxazine resin can be cured through thermally activated ring-opening polymerization without a catalyst, and its mechanical properties can rapidly be developed even at low crosslinking conversion. As a result, polybenzoxazine becomes an excellent candidate resin to replace the traditional reactant for organic and carbon aerogel preparations. Moreover, the thermal and thermooxidative resistance of polybenzoxazine can be improved by enhancing its crosslink density, resulting in high char yield and low flammability (Brunovska *et al.* 1999).

Polymeric foam is a two-phase polymeric material produced by introducing a foaming agent into the polymer matrix. Polymeric foam is important and useful due to its attractive properties, such as light weight, high strength-to-weight ratio, buoyancy, chemical resistance, cushioning performance, shock absorption, and thermal insulation (Perez, 2005). Nowadays, there are a number of applications of polymeric foams, which fire resistance is required such as building insulator, civil structure, passenger and military aircraft, naval vessels, and etc. Phenolic foams are regularly chosen to be used in these applications, because they exhibit excellent fire resistance properties, such as low flammability, low peak heat release rate (PHRR), no dripping during combustion, and low smoke density (Lorjai *et al.*, 2009; Shen and Nutt, 2003; Tseng and Kuo, 2002). However, the traditional phenolic resins still suffer from some disadvantages, such as releasing of by-products during the curing reactions, requiring strong acids as catalysts, toxic raw materials, formation of voids, and limited shelf life (Brunovska *et al.* 1999; Shen and Nutt, 2003). On the other hand, polybenzoxazine not only is able to overcome these shortcomings, but also presents many characteristics which cannot be found in traditional phenolic resins, such as high thermal stability, excellent mechanical properties, easy processibility, low water absorption, near zero shrinkage after polymerization, and molecular design flexibility (Kumar, 2008; Ning and Ishida, 1994). Thus, polybenzoxazine becomes an excellent candidate resin to replace traditional phenolic precursors for the foam manufacturing. Over the past few years, there were a few researches involving polybenzoxazine foam. However, in these studies, the synthetic polybenzoxazine foam was prepared mainly via the resin/glass microballoon composite fabrication technique (Kumar, 2008) For commercialization, simplification of the polybenzoxazine foam production method is necessary. Moreover, since only few studies of fiber reinforced polybenzoxazine foam have been reported, the understanding of the behavior of this composite foam is limited. At this point of view, studying the influence of glass reinforced fiber on polybenzoxazine foam can broaden the applications of this composite.