CARBON FOAM DERIVED FROM COAL AND BIOMASS ORIGIN PITCHES

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Abstract

Carbon foams were developed by using low cost precursors – liquid products evolved during carbonization of agricultural wastes and a low rank coal. Investigation of foaming mechanism and relationship between properties and structure of the carbon foam indicated that softening point and composition of the precursors affect the foam structure and foaming performance. Results of this study show that the properties of commercial coal tar pitch can be taylored to meet the foaming requirements by treatment with H_2SO_4 and HNO_3.

Keywords: carbon foam, synthetic pitches, tar

Introduction

Development of carbon foam from pitches originating from tars of agricultural wastes and a low rank coal is a promising study. In view of the fact that pitches from different precursors may interact to form structures with different texture characteristics. In this study a specific processing procedure involving H_2SO_4 and HNO_3 treatment of two different pitches for carbon foam production is reported.

Results and Discussion

Two pitches obtained from mixtures of tars from agricultural wastes and a low rank Turkish coals (60:40%) were treated at 120^{o}C with concentrated H_2SO_4 and 65% HNO_3. The amounts of HNO_3 and H_2SO_4 added to 100 ml mixture were 3 and 1.5 ml respectively. As a result of this controlled thermo-oxidation treatment pitches of different compositions and softening points were obtained. Some characteristics of the resultant pitches are shown in Table 1.

Foam samples were prepared from the two pitches by varying the temperature of treatment and N_2 pressure. Foaming was carried out in a steel reactor by heating the precursor between 400 and 600^{o}C at N_2 pressure up to 1 MPa. The experimental results showed that foaming process is dependent on the composition and softening point of the pitches used.

Table 1. Solubility class separation of the pitches determined by sequential Soxhlet extraction, %

Sample	**PES**	**PEI-TS**	**TI**	**QI**	**Softening point , ^{o}C**
$Pitch_{HNO3}$	17.38	40.60	36.10	5.92	160
$Pitch_{H2SO4}$	9.10	35.14	37.83	7.93	175

PES - petroleum ether soluble; PEI-TS - petroleum ether insoluble-toluene soluble; TI – toluene insoluble;
QI - quinoline insoluble

Table 2 lists some properties of carbon foams obtained from the two pitches. It is observed that the carbon foam with higher compressive strength are derived from pitches with lower PES content , higher QI content and higher softening point ($Pitch_{H2SO4}$). At the same time, the carbon foam obtained from $Pitch_{H2SO4}$ is has a lower porosity and open-cell structure.

Table 2. Properties of carbon foams derived from synthetic pitches at determined optimal conditions

Precursor	Softening point , ^{o}C	Porosity, %	Open-cell, %	Compressive strength, KPa
$Pitch_{HNO3}$	160	78.1	89.1	650
$Pitch_{H2SO4}$	175	72.3	82.4	730

The porosity and open cell of the foams was calculated by the formula:
Porosity, % = $(1 - B_d / D_{pf}) \times 100$; Open cell, % = $D_f/D_{pf} \times 100$
where D_{bd} – bulk density; D_{pf} – true density of pulverized foam; D_f – true density of the foam

Figure 1 shows SEM and normal photographs of carbon foam produced from $Pitch_{HNO3}$. Scanning electron micrograph show that carbon foam involved in this work does not have a regular cell structure. The foam exhibit mainly a ellipsoidal cell structure with open, interconnected pores between the cells. There are cracks in the sample. The cracks mainly occur between the layers aligned parallel to the cell structure.

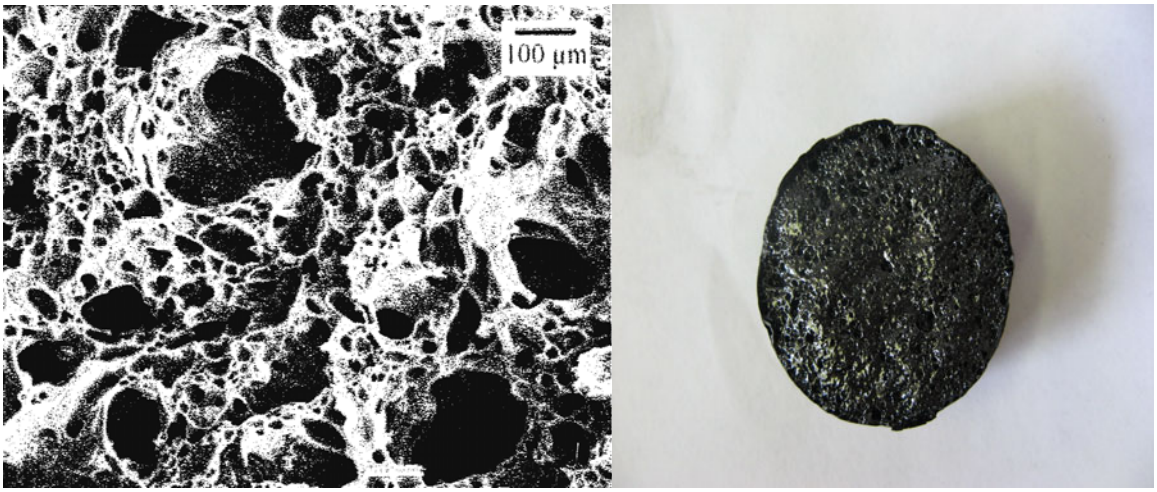

Figure 1. SEM and normal images of carbon foam derived from Pitch $_{HNO3}$

Conclusions

Synthetic pitches obtained from carbonization tars of agricultural wastes and low rank coals are found suitable as foam precursors. The investigation of foaming mechanism and the relationship between properties and structure of the carbon foam and the properties of the precursors indicate that the softening point and composition of the precursors significantly affect the foam properties and foaming performance. These preliminary investigations show that synthetic pitches generate anisotropic carbon foams.