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Sound Absorption of Laminated Biopolymer Foam and Epoxy Foam

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Abstract. Biopolymer foam was prepared based on vegetable oil and Polyol Flexible (Epoxy) with commercial Polymethane Polyphenyl Isocyanate (Modified Polymeric-MDI) as laminated foam. The acoustic property of biopolymer foam was examined by impedance tube test according to ASTM E-1050 of sound absorption coefficient (α). From the result obtain, sample D and sample C are the best result of sound absorption coefficient (α) for biopolymer foam and epoxy foam with the value are 0.867 and 0.817 respectively. By using the sound behavior theory, when the thickness is increase the sound absorption is also increase as same as in this study. The noise reduction coefficient (NRC) of sample D is 38.26% while for sample C is 37.42%.

Introduction

Bio foam with controlled pore size and structure can be produced from biodegradable polymers from renewable resources such as vegetable oils (VOs) obtained from agricultural products of soybean, palm oil, rapeseed, sunflower and coconut. In this research, bio foam and commercial foam is laminate with difference thicknesses is used to examine the sound absorption according to previous studies [1-14].

The sound absorption measurement is related to the capacity of material to absorb, reflect and dissipate energy. Polymeric foams are well suitable for this application. They can undergo large compressive deformation and absorb considerable amounts of specific energy [15].

Organic lamination on the absorbing material may also help in increase the sound absorption coefficient as compared to the product without laminated [16]. Basically, effective sound absorbers are usually porous, with performance increasing with thickness. Another important material properties are included the porosity, tortuosity and flow resistance [17].

Experimental

Raw Materials. The raw materials for biopolymer laminated epoxy foam: bio-monomer based on waste cooking oil monomer [7-14], flexible isocyanate, Polyol flexible (Epoxy).

Foam Production. Bio-monomer based on waste cooking oil from Small Medium Entrepreneur (SME's) was prepared beginning with a preparation of the catalyst [1-14]. The monomer and flexible isocyanate were vigorously and left to cure for 30 minutes stirred, Polyol flexible and flexible isocyanate were mixed and laminated on top of bio-monomer foam. The laminated were then immediately cast into open mould before the foam is expanded out. It was left for 12 hours to reach cured [6]. Fig. 1 shows the biopolymer laminated epoxy foam production.

Fig. 1. Biopolymer laminated epoxy foam

SEM. The top surface of laminated biopolymer foam samples were sputter coated with gold at 25 mA plasma current and 2 Pa of chamber pressure to make them conducting samples. Cellular structure images were examined by using SEM of JEOL-JSM6380LA operates at 15 kV at 30 µm magnifier under high vacuum.

Table 1. Thickness ratio of Biopolymer foam and Epoxy foam

Sample	Biopolymer Laminated Epoxy Foam			
	Epoxy	Biopolymer	Epoxy	Biopolymer
A	4	6	X	X
B	5	5	X	X
C	6	4	X	X
D	X	X	6	4
E	X	X	5	5
F	X	X	4	6

Acoustic Property. The biopolymer laminated epoxy foam with three different ratios of thicknesses show in Table 1, samples were prepared and were tested in two sides near the loudspeaker respectively. Each samples had a different ratio. The samples were tested by using impedance tube test according ASTM E1050 for horizontally mounted orientation sensitive materials for the frequency range of 100-6000 Hz [3]. Impedance tube is used to test sound absorption of the samples at low frequency level by 100 mm sample diameter, while sound absorption at high frequency were determined by using 28 mm sample diameter.

Result and Discussion

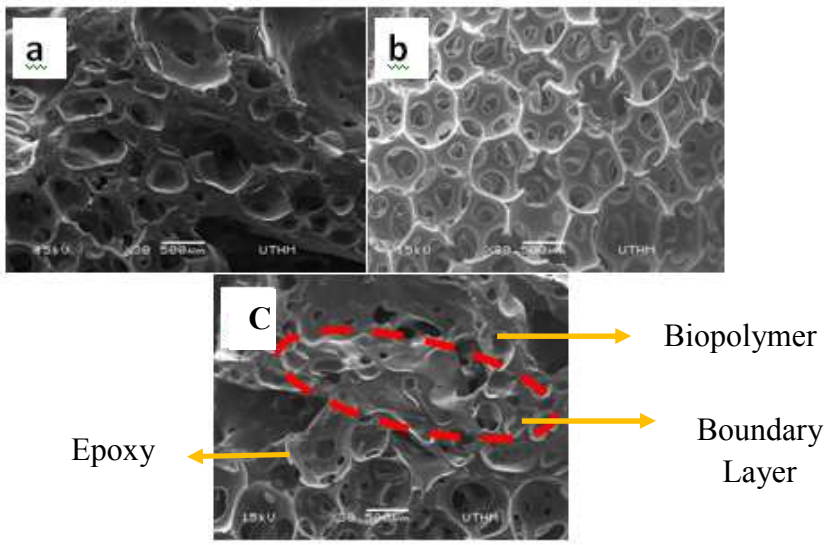

Fig. 2. SEM micrograph : (a) Biopolymer foam, (b) Epoxy foam and (c) Biopolymer laminated foam.

Morphology structure. The morphologies of these foam surfaces were investigated. The SEM images of the surfaces are referred to Fig. 2(a), Fig. 2(b) and Fig. 2(c). When compare the all foams fabricated, larger cells were found on Fig. 2(a) the cellular-structure of biopolymer foam observed from the surface perpendicular to the foam direction. The previous researchers [14,15] Fig. 2(b) mentioned that the open cell were formed from cell which contained many small open-windows located on its cell-wall whilst these open-window formation caused the struts developed throughout the foam system. Fig. 2(c) showed that there was much difference and having non uniform cell structure in between cellular structure of biopolymer foam and epoxy foam.

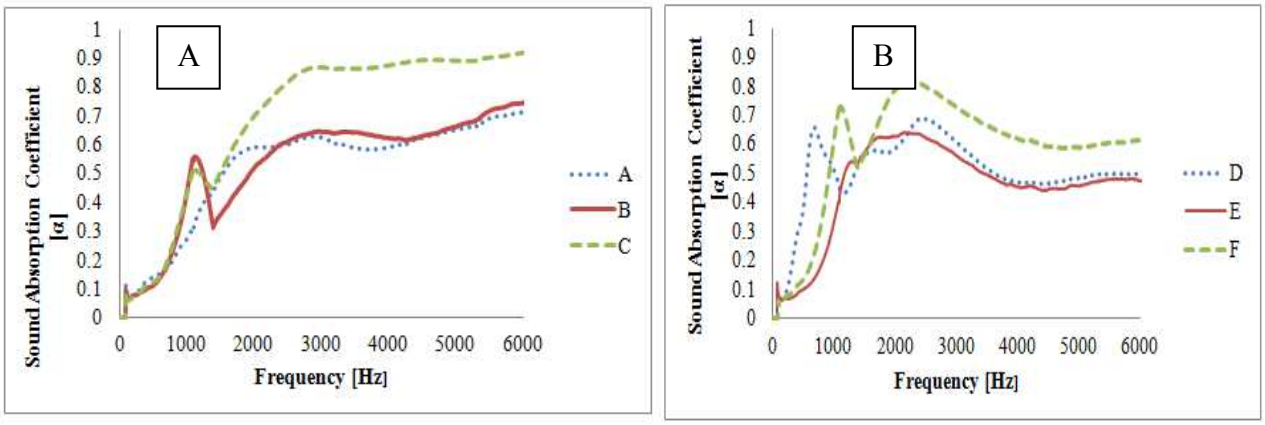

Fig. 3 Sound absorption coefficient of biopolymer laminated epoxy foam with different thickness ratio (A) Sample of Epoxy foam near the loudspeaker (B) Sample of Biopolymer foam near the loudspeaker.

Acoustic analysis. Fig. 3 shows the acoustic absorption behavior of laminated biopolymer foams, depending on their thickness. As the sound absorption increases, the foam thickness also increases from A, B and C at the higher frequency as shown in Fig. 3. The higher value of sound absorption coefficient at C is 0.87. But there are opposite result as shown in Fig. 4 which is foam thickness from D, E and F sound absorption increases but sometime fluctuating data found at the lower frequency. The higher value of sound absorption coefficient at D is 0.82. Hence, C is better than D. Similar observation was found in previous study [16] that is when the thickness of foam increased, the sound absorption coefficient increases to the higher value. This is due to the increased of damping in foams with higher thickness [17].

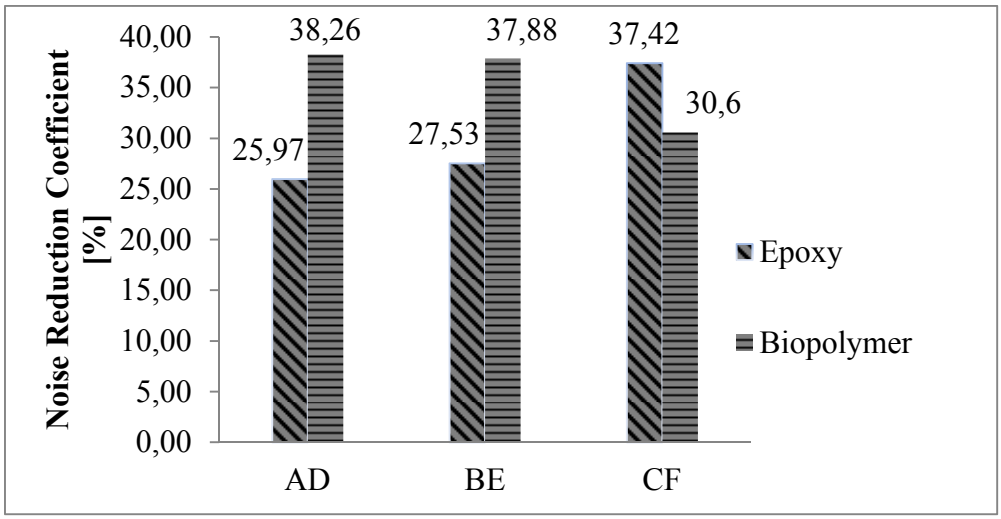

Fig. 4. NRC of Biopolymer laminated epoxy foam

Fig. 4 present results of NRC calculated thickness from 40 mm to 60 mm. In this case, the result clearly showed that for NRC value for Epoxy foam near the loudspeaker increase while the thickness is increase, opposite to NRC value for biopolymer. This is because the sound dampening in polymeric foam is related to the effect of the interaction between different characteristic for both material (Epoxy and Biopolymer foam) and morphology of foam [15,16].

Conclusion

For the conclusion, the cell size diameter of the laminating biopolymer foam and there thickness influences the sound absorption coefficient. When the thickness is increases the sound absorption also increases.

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