

Properties of antimicrobial membrane using an *N*-halamine material

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1. Introduction

Aramid is defined as "A manufactured fiber in which the fiberforming substance is a long-chain synthetic polyamide in which at least 85% of the amide (-CO-NH-) linkages are attached directly between two aromatic rings" by Federal Trade Commission. Recently, due to excellent physical properties applications, aramid are being increased in various fields of study. Aramid fiber is divided into two types, *m*-aramid and *p*-aramid. In particular, halogenated *m*-aramid is one of superior antimicrobial materials for Gram-positive and Gram-negative bacteria.

The aim of this study is making *m*-aramid membranes with PVA (polyvinyl alcohol). Size of void and distribution of the *m*-aramid membranes will be measured. In addition, antibacterial efficacy of the membranes will be also carried.

2. Experimental

Production of membrane

To make *m*-aramid membrane, different concentrations of *m*-aramid and PVA were dissolved in an ionic liquid at 110°C over 12 h until a homogeneous solution.

Methanol was employed at -20°C for coagulation followed by rinsing with methanol. Produced membranes were soaked in distilled water at 100°C for 30 min and dried at ambient temperature. The structure of *m*-aramid is shown in Fig. 1.

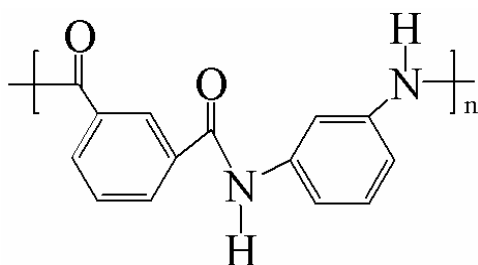


Fig.1 The structure of *m*-aramid

Chlorination

The *m*-aramid membranes were soaked in sodium hypochlorite solution (NaOCl) at pH 7 for 60 min followed by rinsing three times with distilled water.

Chlorinated *m*-aramid membranes were dried at 45°C for 2 h to remove unbonded chlorine. Scheme of the function of *m*-aramid disinfection is depicted in Fig. 2.

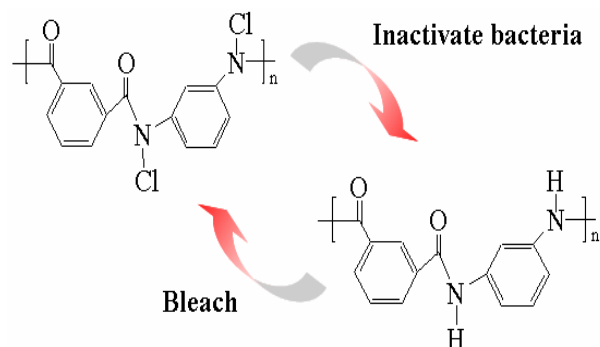


Fig.2 Scheme of the function of *m*-aramid disinfection

Titration

A volume of 100mL-distilled water was prepared with 1mL of acetic acid followed by adding 0.1g of KI. After treated *m*-aramid membrane were soaked in the solution over 12 h, sodium thiosulfate solution was added to titrate the amount of starch which stands for the amount of oxidative chlorine.

3. Measurement

Scanning electron microscopy (SEM) was used to estimate a size of voids as well as void distribution (Fig. 3). An indirect method to measure voids in membranes was conducted with concentration of Cl⁺ (oxidative chlorine) after chlorination and titration. The [Cl⁺]% in the sample was calculated with the following equation(1):

$$[\text{Cl}^+\%] = (\text{V} \times \text{N} \times 35.45) / (\text{W} \times 2 \times 10) \quad (1)$$

Where [Cl⁺]% is the wt% of oxidative chlorine on the sample, V is equal to the volume of the titrant (sodium thiosulfate solution (mL)), N is equal to the normality of the titrant, and W is the weight of the sample (g). The constants, 35.45, are molecular weight of Cl and 2 is the change in oxidation state of Cl during titration, and 10 to normalize the

units in numerator and denominator to give % Cl.

4. Results and discussion

SEM image of membranes used in *m*-aramid and PVA of the different concentrations is shown in Fig. 3. It indicated that the more PVA in the solutions, the higher void rate in the membranes.

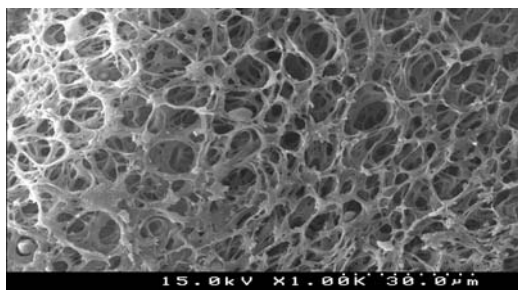
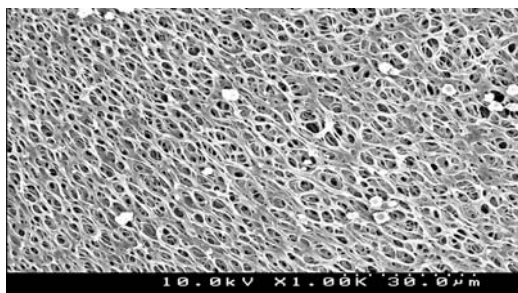
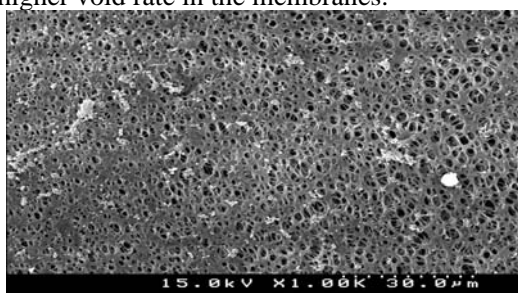


Fig.3 SEM image of membrane used in *m*-aramid and PVA of the different concentration

Oxidative chlorine contents were shown in Table 1.

Table 1. The percent of Cl^+ after chlorination and titration

	$[\text{Cl}^+] \%$
<i>m</i> -aramid:10%, PVA:5%	1.431
<i>m</i> -aramid:10%, PVA:10%	3.953
<i>m</i> -aramid:10%, PVA:15%	3.536

5. References

1. J.Liang, R.Wu, J.-W.Wang, K.Barnes, S.D.Worley, U.Cho, J.Lee, R.M.Broughton, T.-S.Huang, N-halamine biocidal coatings, *J Ind Microbiol Biotechnol*(2007) 34; 157-163
2. Jie Liang, Yongjun Chen, Wuehong Ren, Rong Wu, Kevin Barnes, S.D.Worley, R.M.Broughton, Unchin Cho, Hasan Kocer, and T.S.Huang, Fabric Treated with Antimicrobial *N*-Halamine Epoxides, *Ind. Eng. Chem. Res.* 2007,46,6425-6429