Biocompatabilities of Some Synthetic Polymers in Films

Galhee Kim 1, Jinhwan Yoon 1, Moonhee Lee 1* and Hesseo Kang 2*

1 Department of Chemistry, National Research Laboratory of Polymer Synthesis and Physics, Division of Chemistry, BK21 Program, and Polymer Research Institute, Pohang University of Science and Technology, Pohang 790–784, The Republic of Korea. 2 Department of Microbiology, Dongguk University College of Medicine, Gyeongbuk 780–714, The Republic of Korea (E-mail: lsksm@dongguk.ac.kr)

Introduction

Along with a rapid progress in medicine, the field of organ transplantation has been dramatically expanded. Due to the shortage of supplies from organ donation, however, artificial organs and medical implants are receiving high attention. Materials for artificial organs and medical implants are materials that are to be in contact with the human body. It has been well known that the implants are exposed to passionate bacteria during surgical processes and that a few bacteria circulate in bloodstream, adhere and start to colonize on the surface of prosthetics [1]. Several factors that cause these problems include chemical and physical properties of artificial materials and characteristics of bacteria [2].

In the present study, we chose five different sorts of bacteria, Staphylococcus aureus, Staphylococcus epidermidis, Pseudomonas aeruginosa, Enterococcus faecalis and Bacteriella coli that are most notorious for opportunistic and intravenous infections, and a human cell, Hep-2 cell which is laryngeal carcinoma, and then investigated their adherence behaviors onto film surfaces of Nation®, poly(propylene carbonate) (PPC) and polyethylene terephthalate (PET). PPC film that reveal different chemical and physical characteristics.

Experimental

Polymer film preparations. Nation® and PVHDPF (Mw = 400,000) were purchased from Aldrich Chemical Company while PPC of Mw = 673,000 was synthesized as described elsewhere [3]. Films of PPC and PVHDPF were prepared by hot-press molding at 110°C and 170°C and Nation was prepared by it self respectively, under nitrogen atmosphere. Before use with bacterial assay, the prepared polymer films were characterized using atomic force microscopy (AFM), water and ethanol swelling analysis, water contact angle analysis, and surface energy analysis.

Bacterial adhesion. S. aureus, S. epidermidis, P. aeruginosa, E. faecalis, and B. coli were obtained from the KCCM routinely grown in Nutrient blood (NB) or on NB agar plate. NB was inoculated with a single colony of each bacterium on NB agar plate and incubated with shaking at 37°C for 4 h. The overgrown cultured bacteria was then diluted 100-fold and incubated at 37°C with shaking until a mid-logarithmic phase was reached. The bacterial culture was centrifuged, rinsed in phosphate-buffered saline (PBS), and used for adhesion assays. Dried cultured cells were later plated for counting on NB plates. Then, each polymer sheet was immersed in PBS and each bacterium of a certain amount was added to the PBS containing the polymer sheet, followed by incubation with shaking at 37°C for 1 h. The polymer film was then taken out and rinsed 5 times with PBS, transferred into a tube containing TWEEN 20 in PBS, followed by sonication. After the film was taken out, the detached bacteria were rinsed diluted and plated on NB agar plate for counting their population.

Hep-2 cell adhesion. Hep-2 cell line was purchased from KCLB. Cell growth was recorded using an optical microscope (Nikon CoolView5400) equipped with a digital camera. These three polymer films were cut into squares (1 x 1 cm) and sterilized by 70% ethyl alcohol for 10 min and then washed in Dulbecco's PBS solution (pH 7.4) for 3 h. Hep-2 cells were added to the polymer films in the T-25 culture flask; the medium was changed every other day until confluent monolayer was obtained.

Results and discussion

Polymer film properties. Film surface was examined by AFM, the root mean squared roughness was 2.8 nm, depending on the polymer film. Nation film showed high swelling in the buffer solutions, which results from the ionic characteristic due to its sulfonic and groups. In contrast, both PVHDPF and PPC revealed poor swelling in the buffer solutions.

Bacterial adhesion. The bacterial adhesion were found to be in increasing order Nation film < PPC film < PVHDPF film. These results indicate that bacteria show a strong tendency to adhere more onto hydrophobic polymer film surface, such tendency is decreased with increasing hydrophilicity and ionic strength on the polymer film surface.

Cell adhesion. Hep-2 cell showed to be favorably adhere on the Nation and PVHDPF films (Figure 1). However, surprisingly the cell did not adhere on the PPC film (Figure 1). The results suggest that Hep-2 cell favors adhere on the hydrophobic and ionic polymer film surface as well as on the highly hydrophobic polymer surface.

Figure 1. Optical microscopy images of Hep-2 cells on polymer films (a) PPC, (b) Nation, (c) PVHDPF.

Acknowledgments

This study was supported by the Korea Science & Engineering Foundation (National Research Lab Program (NRL for Polymer Synthesis and Physics) and Science Research Excellence Program (Center for Integrated Molecular System) and by the Ministry of Education (BK21 Program).

References