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Platelet Adhesion onto Modified Polymeric Surfaces by Ozone Oxidation

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Surface modification via ozonation has been studied to improve biocompatibility of polymeric biomaterials. The degree of ozonation measured by iodide method was dependent on the ozone permeability of the polymers to be in the order of PU>silicone>>PE>PMMA (after 1 hr), but it was increased gradually to large amount for PMMA. Contact angles were investigated in terms of surface reaction and resulting hydrophilization. Ozonation yielded an moderate increase of hydrophilicity and decrease of platelet adhesion. Such a technology using ozone treatment was relatively simple to introduce uniform surface hydrophilization, and therefore very useful for actual application of blood contacting medical devices.

Key words : Ozonation, Wettability, Platelet adhesion

INTRODUCTION

A variety of approaches have been carried out to improve the blood compatibility and to minimize cell adhesion on biomaterials surfaces.[1,2] One approach involves surface hydrophilization by various methods. Hydrophilic surfaces and hydrogels have low interaction with blood and cells which are mainly composed of water. There are many studies to demonstrate improved biocompatibility of these materials[3]. Surface ozone oxidation is widely applied in polymer areas as it has an advantage of uniformly introducing peroxides on the surface of polymer and an easily handling technique.[4-7] When polymer is exposed to ozone gas, carbonyl and carboxyl groups are formed in addition to peroxides.[8] The generated polymeric peroxides are capable of initiating polymerization of vinyl monomers, resulting in surface grafting onto the ozonated polymeric materials.[4] Such polymeric surface oxidation can be proceeded also by irradiation with gamma-rays,[9,10] electron beams,[11] and ultraviolet radiations[12] in addition to glow[13] or corona[14-17,21] discharge. However, ozone method has an superior advantage over those with respect to uniformity. It is well known that oxidation of polymeric films by ozonation occurs not only onto surfaces but also into bulk due to the diffusion of ozone into the film.[4] And peroxides evolved by ozonation can be decomposed significantly on storage at room temperature.

This article describes ozone treatment on polymethylmethacrylate (PMMA), polyethylene(PE), silicone, and polyurethane(PU). The surface structures and properties of modified polymers were investigated using electron spectroscopy for chemical analysis (ESCA), atomic force microscopy(AFM) and dynamic contact angle (DCA) measurements. Also, the blood compatibility of modified polymers was evaluated by platelet adhesion study.

MATERIALS AND METHODS

Materials

Polyurethane(PU)(Pellethane, Dow Chemical Co., Midland, MI, U.S.A.) was extracted with methanol for 3 days to remove low molecular weight components and dried under vacuum. The extracted PU was casted into films from N,N-dimethylacetamide solution and dried for 1 week at 45 °C. Polymethylmethacrylate (PMMA), commercial sheets(LG Chemical Co., Korea), was washed by ethanol for 3days. Low density polyethylene(PE) films were purchased from Hanwha Petrochemical Co., Korea. Silicone sheets were supplied from Yushin Medical Co., Korea. All the sheets (size 1×3 cm, thickness 0.5-2 mm) were further sonicated for 30 min before ozone treatments.

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