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Artificial biomembrane models using polymer giant vesicles: Morphological changes and enhanced permeability of the vesicles by incorporation of ionic segments into the polymer amphiphiles

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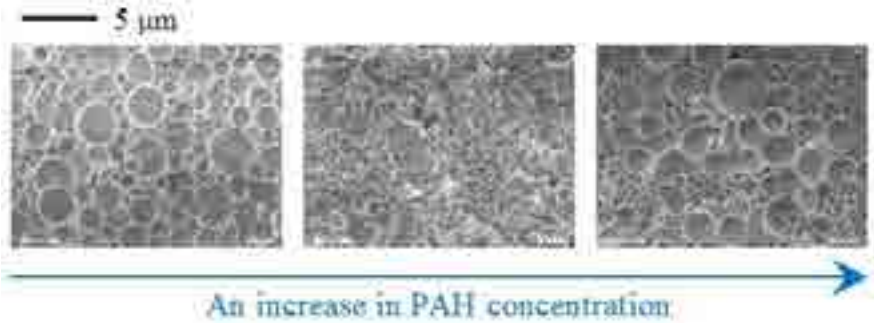
Microsized giant vesicles comprised of an amphiphilic poly(methacrylic acid)-block-poly(methyl methacrylate-random-methacrylic acid) diblock copolymer, PMA-b-P(MMA-r-MA), are possible artificial models of biomembrane for cells and organelles based on the similarities in their size and structure. The similarities include morphological variation based on critical packing shape of the diblock copolymer, membrane fusion and fission and stimulus-responsiveness. This paper describes the morphological changes in the vesicles by incorporation of ionic segments into the hydrophilic PMA block and the transformation by electrostatic interaction with a polyelectrolyte on the hydrophilic surface of the vesicles. The permeability enhancement of the vesicle bilayer by incorporation of the ionic segments into the hydrophobic P(MMA-r-MA) block is also described. The morphological changes in the spherical vesicles were investigated by incorporation of the 3-sulfopropyl methacrylate potassium salt (SpMA) into the hydrophilic PMA block. The vesicles were reduced in size as the SpMA units increased due to the expansion of the hydrophilic surface area for critical packing shape of the copolymer by the incorporation of the more hydrophilic ionic segments. The increase in the SpMA units delayed the transition from the spherical vesicles to a sheet-like bilayer. The SpMA-containing vesicles were disrupted into a nonspecific form by the electrostatic interaction with poly(allylamine hydrochloride) (PAH). A large excess of the polyelectrolyte caused partial fusion of the vesicles rather than disruption (Figure-1). The vesicles with the SpMA incorporated into the hydrophobic P(MMA-r-MA) block also changed from spherical to sheet-like as the SpMA units increased. The SpMA units enhanced the permeability of Rhodamine B (Rh) into the vesicle bilayer, whereas the vesicles without SpMA captured no Rh molecules. It was demonstrated that this permeability enhancement was attributed to the pore formation in the bilayer by the capture and release of the Rh by the SpMA units in the hydrophobic phases.



Biography

Eri Yoshida is an Associate Professor of Toyohashi University of Technology, Japan. She has received her PhD in Polymer Engineering from Tokyo Institute of Technology and Bachelor's degree in Education from Tokyo Gakugei University. She has worked at Kyoto Institute of Technology as an Assistant Professor. She was also a Visiting Scientist at University of North Carolina at Chapel Hill. She has more than 100 peer reviewed scientific publications and obtained over 20 patents. She is a Member of the Editorial Board of several international peer reviewed journals. Her research interests include molecular self-assembly of polymer amphiphilies, controlled/living radical polymerization, molecular design of functional polymers and polymer syntheses using supercritical carbon dioxide.

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