SAXS-revealed nanostructures of poly(ethylene glycol)-grafted phospholipid vescicles

Chun-Jen Su[1]*, Cheng-Han Li[1], Hua-De Gao[2], Hsien-Ming Lee[2,], U-Ser Jeng[1,3]

[1]National Synchrotron Radiation Research Center, Hsinchu, Taiwan

[2]Institute of Chemistry, Academia Sinica, Taipei, Taiwan

[3]Department of Chemical Engineering, National Tsing Hua University, Hsinchu, Taiwan

su.cj@nsrrc.org.tw

Liposomes have attracted increasingly higher attention due to its wide applications in bioengineering and drug transport. To prolong the circulation time of liposomes, it is advantageous to graft poly(ethylene glycol) (PEG) at the liposomal surface for so-called PEGylated liposomes. The grafted PEG layer increases the miscibility of the drug-carrier liposomes in blood, and reduces changes of being targeted by opsonins. In this study, EGylated liposome solutions, of tens of nanometers, prepared with the different surface-modified phospholipids, are studied using synchrotron small-angle X-ray scattering (SAXS). A 5-layer model is developed for the SAXS data analysis, to resolve the nanostructures of the complex vesicles of PEGylated phospholipids. The proposed model employs five Gaussian functions to represent: one central layer of the lipid-tail zone in the liposome vesicles, which is sandwiched by two layers of phosphate head groups of the lipids, and further capped by two outermost layers of PEG of the unilamellar vesicle bilayer of the liposomes. The 5-layer model could fit decently the SAXS data and reveal the thickness and electron-density of each sublayer of the PEG-grafted vesicle bilayer of the liposome. The structural changes observed are further correlated to the drug releasing efficiency observed, providing a structural basis for the design of controlled drug delivery.

Keywords: SAXS, PEGylated liposomes, membrane structure, drug delivery