Abstract of this thesis

This research aimed to design the bio-mimetic interface with biochemical and physicochemical properties, and the preparation and the functional analysis of dendrimer interface were discussed in this thesis.

In chapter 2, the dendritic sugar interface mimicking the cell membrane was prepared by means of SAM and click chemistry. The azide terminated dendritic sugars with various generations (α-Man, β-GlcNAc and β-Gal) were synthesized by organic metathesis. These sugars were immobilized on an acetylenyl-terminated gold substrate via click chemistry. The sugar microarray was utilized for the interaction and kinetic analysis forward the lectins of Con A, WGA and RCA_{120} by SPR, quantitatively, after the surface property was investigated by ellipsometry, FTIR-RAS, QCM, water contact angle goniometry and XPS. Each association constant was unique to specific lectin and increased as the generation increase. Moreover, each tendency for kinetic constants to change was unique to each interaction between sugar and lectin, implying specificity of the multivalent effect of sugar-lectin interaction.

In chapter 3, the mechanism of amyloidosis of Aβ (1–42) was investigated by the well-defined glyco-cluster interface. Aβ (1–42) is correlated to 6S-GlcNAc of the sulfate sugar on the cell membrane. Preparing monovalent, divalent and trivalent 6S-GlcNAc immobilized substrates by organic metathesis and thin-layer technique, the morphology and secondary structure of Aβ (1–42) aggregates on 6S-GlcNAc derivatives immobilized substrates were investigated and a spherical aggregation and few β-sheet structure were clarified on the sugar immobilized substrate with higher valency. The interaction between the substrate and Aβ (1–42) was also evaluated and the change of binding mode was founded. These changes of Aβ (1–42) aggregation reflected the higher cytotoxicity on the sugar immobilized substrate with higher valency. These analyses suggested that the exhaustive multivalency of sugars for the amyloidosis of Aβ (1–42) was significant in its morphology and aggregation effects at the surface of the cell membrane mimic.

In chapter 4, SAMs of hemispherical PAMAM dendrimer were prepared on the gold substrate via

Au-S bond. The dendrimer layers with succinic acid termini showed the strong wettability based on the densely packed hydrophilic group and high surface roughenss. The phenomenon was observed on the dendrimer layer with succinic acid termini, and was not on the dendrimer layer with amine termini. FTIR analysis and D-AFM suggested that the tendency of wettability was also dependent on the 3D-structure of the dendritic layer with succinic acid. In this chapter, it is suggested that dendrimer is attractive tool for the design of surface property, and has possibility to control the surface not only chemically but also physicochemically.

Though this thesis clarified that the dendritic surface presented the multivalent biofunctional groups in 3D compared to the conventional surface, the accurate presentation of biofunctional group in nanoscale enables to elucidate the life phenomena such as the pathogenesis of AD. The dendrimers also contribute to modification of the surface property by changing the dendritic scaffold or dendritic layer structure, which is correlated to the fractal nature of dendrimer.

Considering the well-known property of dendrimer, the dendritic surface with larger dendrimer becomes hierarchical, and the accurate arrangement of biomolecule for the precise molecular recognition or biochemical reaction will be accomplished in mesoscale. The dendritic surface is able to work as biomimetic surface and contribute to clarify the living system and to fabricate the novel materials.