Investigation of biocompatible DLC films by Neutron Reflectometry

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1. Introduction

DLC (diamond-like carbon) film has attractive properties such as high hardness, wear resistance, low friction, and biocompatibility. In our previous work, N-containing DLC had good blood compatibility and effect on enhancement of cell proliferation. It is well known that these biological responses are strongly depended on electrical properties as surface conditions of the DLC films based on film structures. Neutron reflectivity measurement that can quantitatively evaluate hydrogen content is suitable for evaluation of DLC film structure. In this study, for film structure and compositional effects of DLC on biological response, structure of N-containing DLC film was investigated by Neutron reflectivity.

2. Experiment

DLC film was deposited at 100 nm on Si wafer (diameter: 2 inches, thickness: 5 mm) by r.f. plasma CVD process. The plasma power was kept at 100 W constantly, and decomposed mixture gas of CH_4 + N_2 gas at 100 Pa and 50 sccm with a deposition time of 10 minutes constantly. At the film deposition, N_2 flow rate was control at 60 %. Albumin and NIH-3T3 cells were used to estimate biological responses on the DLC film deposition. Albumin solution and the cells in D-MEM solution were seeded on the DLC films, respectively. These were incubated at 37 ℃ in an atmosphere consisting of 5% CO2 and 95% air with a relative humidity of 100%. Neutron reflectivity measurements, in front incidence and back incidence, were performed with Neutron Reflectometor “SHARAKU” (BL17) in MLF J-PARC. Q range for measurements was set to 0.005～0.16 ($Å^{-1}$).

3. Results

The results of neutron reflectivity in front incidence and back incidence on N-containing DLC film showed that the scattering length density of the N-containing DLC is different with the typical DLC (CH_4 deposition), and it was found that a layer with a small scattering length density is formed on the surface. It was observed that the biological responses (albumin and cell adhesion) depend on DLC film structures. The N-containing DLC enhanced cell adhesion.

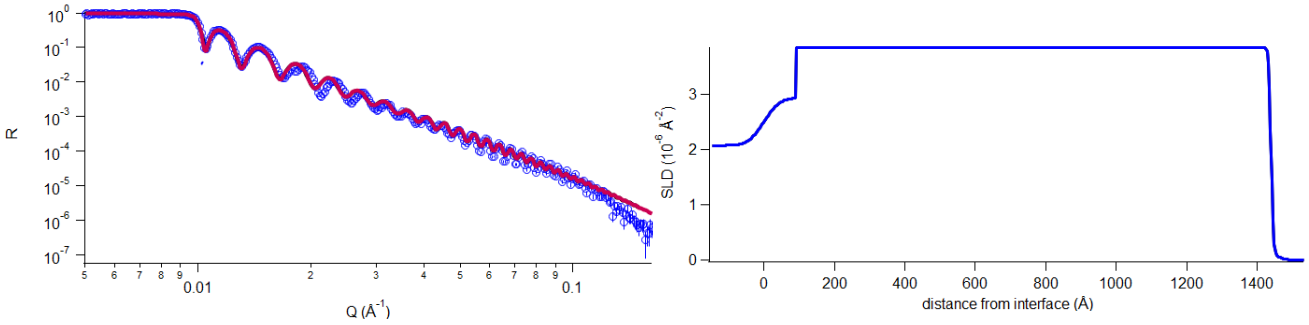

Fig. 1 Neutron reflectivity and SLD profiles of DLC (CH_4 deposition)

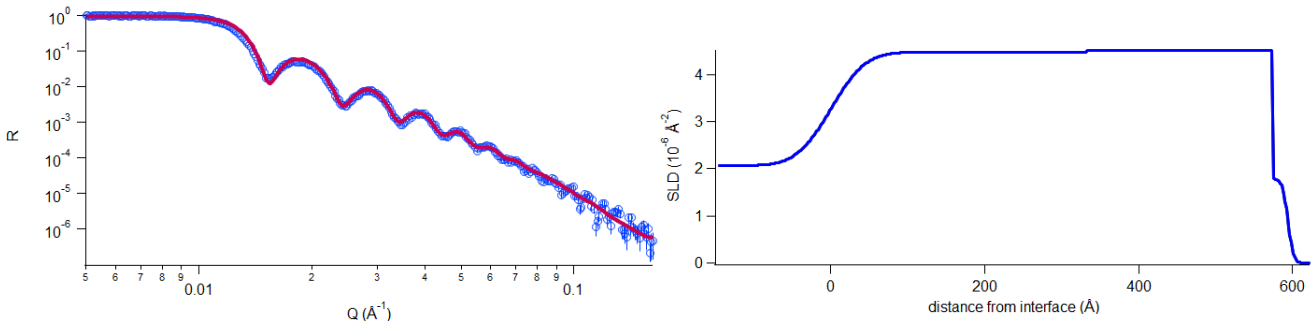

Fig. 2 Neutron reflectivity and SLD profiles of N-containing DLC (CH_4 + N_2 deposition)

4. Conclusion

Based on these results, relationship between the film structure and biological response based on film properties of the N-containing DLC film in detail will be investigated.