Horizontal type neutron reflectometer ARISA-II at J-PARC/MLF

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Neutron reflectometry is one of the powerful tools to investigate surface and interfacial structures of materials in the spatial range from nm to sub-μm. Because hydrogen and deuterium atoms have different scattering length for neutrons, this method can distinguish deuterated materials from normal ones in the mixture of soft-condensed matters, such as polymer blends, bio-mimic membranes, and so on. In J-PARC/MLF, we started to accept the neutron beam on ARISA-II reflectometer in December 2008, and installed disk chopper as a tail cutter, mirror holder to control beam path, iron collimator and shielding around detector for background suppression in 2009. Thanks to the upgrades, the beam intensity was dozens of times more than that in KEK, and the observable reflectivity reaches around 10^{-6} (at the proton power of 120 kW, time-resolved measurement with a few minutes duration could be performed). Furthermore, we installed a detector consisting of a ^{6}LiF/ZnS scintillator plate and 2-dimensional photomultiplier tube. This enable us to measure specular and off-specular reflection at the same time. But we still had some problems on backgrounds due to very high energy neutrons and low energy neutrons, because these neutrons cannot be stopped by the disk chopper.

For background suppression, we have installed a T0 chopper, an iron block synchronously rotating with neutron pulse generation at 25 Hz, and Ni mirror filter. Since iron effectively stops high energy neutrons and Ni mirror totally reflects low energy neutron, these combination can cut neutrons passing through the disk chopper. Figure 1 shows the reflectivity profile of a Si substrate with T0 chopper and Ni mirror filter, in which the momentum transfer normal to the substrate, $Q_z(= 4\pi \sin\theta/\lambda)$, changes with the incident angle, θ, and wavelength of neutrons, λ. Since the reflectivity curves are proportional to Q_z^{-4} and consistent with those at different angles, we conclude contamination due to the high and low energy neutrons were successfully removed . Remarkably, the reflectivity reaches almost 10^{-7} without any background subtraction. This background level is same or less than that of other reflectometers utilizing pulsed-neutron.

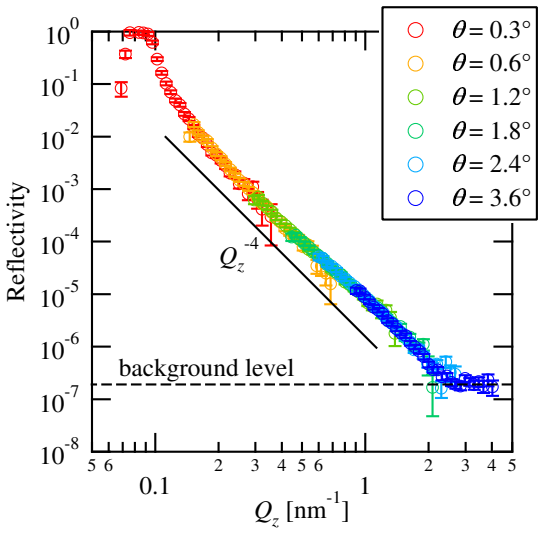

Figure 1: Reflectivity profile of a Si wafer with T0 chopper and Ni mirror filter.

On the presentation, we will show the other results of upgrades in 2010 as well as the background suppression: an auto-scan system with sample changer, data conversion system with GUI, and double-frame mode for time-resolved measurement with wide-Q_z region.