Experimental Study on Neutron Diffuse Reflection due to Surface Roughness for nEDM measurement

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A new experimental search for neutron electric dipole moment (nEDM) is prepared at J-PARC which utilizes high density ultracold neutrons (UCN) generated with pulsed proton beam. For high precision measurement, it is important to control the degree of surface roughness of the experimental devices. The surface roughness (~ nm or sub-nm) on actual materials causes relatively prominent diffuse scattering (or nonspecular reflection) of UCN. Nonspecular reflection on the UCN guide tube decreases the transportation efficiency. On the other hand, the measurement cell requires a certain level of the surface roughness because ordered motion of UCN ruled by specular reflections spoils the uniformity of the measurement condition and causes systematic errors.

For design of materials on these components, we studied the dependence of the surface roughness on the nonspecular reflaction. The promising materials are nickel/carbon mirror and diamond-like carbon mirror. The neutron reflectivity of these samples was measured with a neutron reflectometer SOFIA at BL16 in J-PARC/MLF. The structure of surface roughness was observed with an atomic force microscope and a scanning white light interferometer in each spatial scale. The results were also compared with the theoretical models based on the distorted wave Born approximation [1, 2]. We will report the status of study and discuss the suitable roughness structures for the nEDM measurement.

References

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