Cold and Ultra-cold Neutron Source Studies

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This talk will be focused on two topics. The first part of this talk is about the cold neutron moderator studies in Low Energy Neutron Source (LENS) at Indiana University Cyclotron Facility (IUCF). We have constructed an approximate microscopic model for the neutron dynamic structure factor of solid methane in phase II, in which the hydrogen tetrahedral exist in a mixed phase of free rotors and hindered rotors. The model treats the effects of molecular translations, intramolecular vibrations and the free and hindered rotational degrees of freedom as uncoupled ones. Total scattering cross sections calculated from the model agree with the cross section measurements for the incident neutron energies of 0.1 $meV \sim 1\ eV$. Neutron scattering kernels for MCNP were produced at 20K and 4K from the frequency spectra using NJOY code. We have tested this model by calculating the neutron spectral intensity expected from the methane cold neutron moderator at the LENS neutron source using this model at 4K and 20K. Within the expected accuracy of our approximate approach, The model predicts both the neutron spectral intensity and the optimal thickness of the moderator at both temperatures. To validate the simulation, we also measured neutron spectral intensity at the temperatures, 20K and 4K. In this talk, the theory of the scattering model and the comparison of simulation with the measurement results will be presented.

The second part is the study of solid oxygen as a ultra-cold neutron source. Ultra-cold neutrons are neutrons with energy of a few hundred neV. This energy is so low that UCN experience total external reflection from material surface. High precise measurements of fundamental physics such as neutron lifetime measurements or neutron EDM are possible with UCN. However, a deficiency of intensity restricts us from achieving meaningful measurements. A UCN source with higher intensity is necessary to perform these precise measurements. Solid oxygen may be an attractive choice as a UCN source with this demand. Theoretical calculations predicted the possible advantages of solid oxygen. However, it has been experimentally shown that the UCN production rate from solid oxygen highly depends on the crystal condition, especially at low temperature. We tested crystal growths of solid oxygen over a wide range of temperature. Now, we are testing UCN productions in solid oxygen under various conditions in FP-12 at LANSCE. The crystal growth of solid oxygen and UCN production study will be discussed.