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Nouvelle génération de réflecteurs à neutrons lents utilisant des nanodiamants purifiés

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Advances in neutronics are of great importance in fundamental science in many fields, from biology to physics. Slow neutrons (SN) are highly interesting to probe material since they are the only neutron type allowing the diffraction phenomenon. However, today most efficient SN reflectors are limited in the range of useful neutrons. This is mainly due to the nature of neutron reflectors, as they are composed of atoms generally spaced of ~ 1 Å, as soon as the neutron wavelength reaches this value the neutrons are almost no longer diffracted. The key to increasing the efficiency of the SN flux therefore lies in the development of efficient reflectors.

Our strategy is to mimic standard reflectors and replace the atoms by nanoparticles of highly scattering materials with low absorption: detonation nanodiamonds (DNDs) and fluorine graphite intercalation compounds (F-GIC). This new class of reflectors will provide a virtually continuous reflectivity curve, with a high albedo minimizing the so-called neutron reflectivity gap.

DNDs are available in an industrial scale and extremely stable under neutron fluxes. However, they contain some impurities that are unfavourable for neutron applications because of their high neutron absorption (e.g. hydrogen, sp^2 C, surface functional groups or metallic impurities). Thus, ultrapure DNDs are highly required for this application.

Our approach to selectively purify DNDs is based on a combination of gas phase purification treatments: chlorination and fluorination. They will respectively remove the metallic impurities and eliminate the surface functional groups and sp^2 C shell. Fluorination will allow the increase of the interplanar distance between graphite layers.

In addition, the design of a unique neutron experimental set-up at the PF1B line at the ILL aims to record simultaneously reflectivity and diffraction of neutrons with a wide range of wavelengths, including slow and very slow neutrons. Data on various powdered DNDs and F-GICs were recorded as well on the precursors before fluorination.