Design of new materials from nano to macro

through the example of nanostructured carbon material assembly for neutron reflector

This lecture gives a representative example of a multidisciplinary work aiming to develop a new class of materials: reflectors for slow neutrons. For that purpose, nanomaterials (nanodiamonds) are treated and densify in order to design a reflector. Halogenation (fluorination and chlorination) will be especially investigated to chemically modify and purify the nanoparticles. Another process allows the densification of the powder without change of the particle diameter and without use of any binder. Neutron and synchrotron radiation techniques, and the diffusion of neutrons are carried out on the resulting powders. Each of these topics will be described generally and more specifically for the application as slow neutron reflector.
Beyond the specificity the example of material designed here, this self-consistent course will give a great example of a multidisciplinary collaboration involving chemists and physicists of materials as well as physicists of neutrons who join their competencies to develop a new material. Such a knowledge is of great interest for future researchers in material science.

This course is addressed to all PhD students of the EDSF, no specific knowledge of material and neutron science is required.

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Introduction : Slow neutron reflectors, applications and drawbacks; strategy to develop the first slow neutron reflector by replacing the atoms/nuclei by nanoparticles

Part I –

I.1 The carbon nanomaterials, their potentialities and their chemical treatments towards applications

I.2 Controlled and reversible chemical modification of carbon nanomaterials: possible approaches including fluorination, interests and properties

I.3 Assembly of nanomaterials: focus on densification and high pressure synthesis, from basic concepts to applied processes

Part II – Characterization of nanomaterials using neutrons, investigation of slow neutron reflectivity