DIRECTION DES SCIENCES DE LA MATIERE, INSTITUT RAYONNEMENT MATIÈRE DE SACLAY
SERVICE DE PHYSIQUE ET DE CHIMIE DES SURFACES ET DES INTERFACES

SEMINAIRE

Vendredi 22 Novembre à 11h00

Bâtiment 466, salle 111 - CEA Saclay, 91191, Gif sur Yvette

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(invité par Patrick Soukiassian)

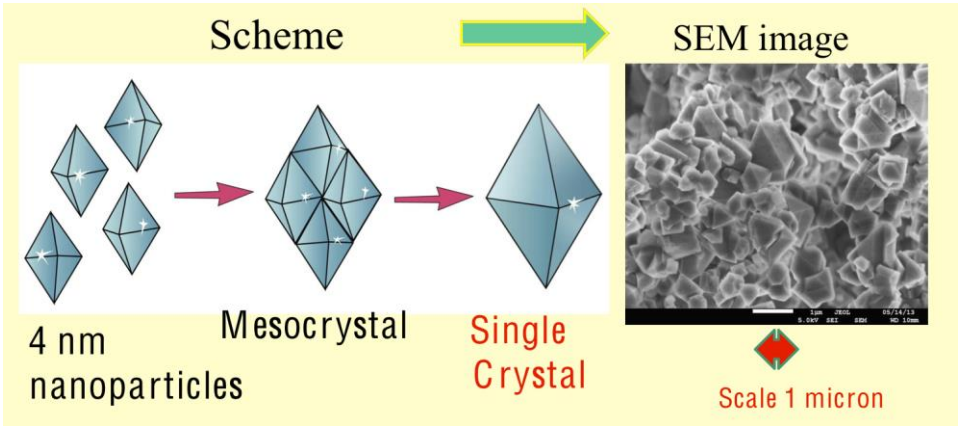
Detonation NanoDiamond: Technology, Properties and Applications

On the turn of the last century, the newly coined word "nanotechnology" (NT) has become one of the most popular and widely used terms. Carbon nanostructures have been considered as the main initial materials suitable for the NT since the fullerene discovery. This presentation will addressed new features of technology, structure, properties and applications of a nanocarbon family member – the detonation nanodiamond (DND).

Purification, de-agglomeration and functionalization of industrial DND: It is well known that a non-vanishing amount of residual metal impurities in DND, mainly 3d transition metals is an important and unsolved problem of industrial DND technology for several DND applications. We demonstrate a method for super-purification of the industrial DND and EPR as an effective characterization method for control the purity of DND destined for biomedical applications. A commercial powder of DND and their aqueous suspensions consist of submicron agglomerates of 4 - 5 nm crystalline diamond grains. We have recently submitted a method for disaggregation and production of stable hydrosol of 4 nm isolated DND particles. We have demonstrated that 4 nm DND hydrosols produced by annealing in air and hydrogen atmospheres differ from each other by sign of their zeta potentials and submit a model of this effect. One of the attractive features of DND is possibility for surface functionalization by metal using ion exchange, we demonstrated a possibility of surface modification DND agglomerate by Cu, Co, Ni, Fe and detected three dimensional position of the metal atoms. One of unusual properties of DND, we revealed is oriented attachment growth of submicron diamond crystals from 4 nm grains after high pressure and high temperature (HPHT) sintering. This HPHT treatment has an affects to thermal conductivity and concentration impurities and defects in sintered microcrystals.

Applications of detonation nanodiamonds: In view of the unique combination of DND properties, it appeared only reasonable to assume that this material would find broad application in various areas of technology. Probably the first DND application was associated with development of abrasive compositions for ultrafine mechanical polishing of hard surfaces, including optical elements, semiconductor substrates. Another rapidly expanding area of DND application is the technology of seeding at CVD diamond film growth. Progress in the technology of formation of crystallization centers based on the use of suspensions of 4-nm DND particles permits one presently to prepare diamond photonic crystals.

First reports on the use of DND as catalyst carrier have recently appeared. By using a neutral, chemically resistant phase in the form of particles on which a thin film of catalyst, primarily a metal of the platinum group, was deposited, one can enhance substantially the catalysis efficiency, while at the same time cutting noticeably the consumption of noble metals. A promising application of DND as biomarker is based on using its luminescent properties deriving from nitrogen-vacancy defects in the crystal structure of its particles. High-pressure sintering of DND reveals the presence of nitrogen luminescent centers N0 (N-V)- in concentrations as high as 10-20 cm^{-3}.



Oriented Attachment Growth of Single Diamond Crystals from NanoDiamonds.