# Carbon-based nanomaterials and interlayers for spontaneous, reagent-free surface immobilization of functional macromolecules

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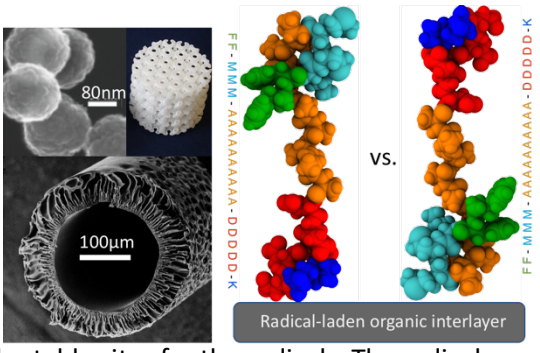


Carbon nanolayers and nanoparticles prepared or post-treated with energetic ions have been found to contain long-lived embedded radicals, also known as dangling bonds [1]. These radicals decay slowly over periods of years [2] by moving to the surface through a temperature activated diffusion process [3] and they react with proximate molecules when they reach the surface. Carbon based materials activated in this way with energetic ions are typically amorphous and they contain nanoscale π-coordinated clusters with delocalized electronic states that provide relatively stable sites for the radicals. The radicals are believed to diffuse by hopping from cluster to cluster. When they arrive at a cluster at the surface and in contact with molecules in the environment, they react chemically with the proximate molecules enabling a simple, reagent-free method of surface functionalization.

Covalent immobilization of functional (including biologically functional) molecules is achieved by immersion, or spotting / painting of the molecule containing solutions. This simplifies the process of covalently functionalizing surfaces enormously, eliminating the need for multiple stage, wet-chemistry and the associated process control, side-reaction and variable yield problems. To date this approach has been used to surface immobilize bioactive peptides, antibodies, enzymes, single stranded DNA and extra-cellular matrix proteins [4] onto the surfaces of many materials, including complex three dimensional structures with internal porosity, for a wide range of applications, particularly for use in biomedical diagnostics and implantable medical devices.

This presentation will summarize the underpinning fundamental science. Processes that create multi-functionalisable radical-laden organic interlayers on the internal surfaces of porous structures will be discussed. Applications enabling biological studies of the response of individual cells to proteins on a sub-cellular scale [5]; the creation of anti-microbial and osteogenic orthopedic implants [6,7,8] and the synthesis of covalently multi-functionalisable nanoparticles for theranostics [9] will be discussed. The physico-chemical mechanisms that underpin the surface immobilization of functional macromolecules will be described together with a practical scheme for controlling the density and orientation of surface immobilized bioactive peptides [10].

## References

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