Revealing the hidden microstructure: inorganic thin-film growth on carbon nanoarchitectures

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The development of advanced inorganic–carbon hybrid materials requires synthesis strategies that provide precise control over composition, structure, and deposition homogeneity while minimizing the environmental impact of the process. Conventional solution-based approaches often rely on organic solvents, surfactants, or hazardous chemical precursors, including persistent substances such as per- and polyfluoroalkyl substances (PFAS). Developing solvent-free and chemically benign routes to complex hybrid architectures is therefore an important challenge. Gas-phase deposition methods offer an attractive alternative, combining solvent-free processing with precise control over the chemistry and structure of deposited materials, while enabling homogeneous coatings on complex and three-dimensional substrates. Among these techniques, magnetron sputtering offers considerable flexibility through the control of deposition parameters, enabling the growth of inorganic thin films with tunable composition, morphology, thickness, and microstructure. In this context, I will present our recent findings on the growth of thin films on carbon nanotube networks by magnetron sputtering, focusing on how deposition conditions and substrate topography influence film growth, morphology, and microstructure. These results highlight the potential of solvent-free gas-phase deposition as a versatile route toward controlled and more environmentally sustainable inorganic–carbon hybrid materials.

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Brigitte Vigolo is a CNRS Research Scientist at the Institut Jean Lamour (IJL), CNRS–University of Lorraine, in Nancy, France, where she has been a member of the institute since 2004. She received her PhD in Physical Chemistry of Condensed Matter from the University of Bordeaux, France, and completed postdoctoral research at the Complex Fluids Laboratory (Rhodia–CNRS) in the USA and at IPCMS in Strasbourg, France. Her research initially focused on the chemistry and physicochemistry of carbon nanomaterials, including carbon nanotubes, graphene, and nanodiamonds, with particular emphasis on their processing, functionalization, and dispersion. Since 2021–2022, her research has evolved towards carbon–inorganic hybrid materials, with a particular focus on hybrid thin films combining carbon nanomaterials with metal-based compounds. Since 2023, she has been leading the “Thin Films for Energy and Applications” research team, a 25-member team at the Institut Jean Lamour. Her current research focuses on the growth and processing of inorganic thin films on rough substrates, with particular interest in magnetron sputtering and the development of controlled architectures. She has authored more than 130 peer-reviewed publications and holds three patents.