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Carbon nanotube growth on TiSiN supports by solid-state dewetting of ultra-thin cobalt films

A Andalouci, M Chérif and S Farhat
LSPM, CNRS – UPR 3407, Université Paris 13, France

Simultaneous synthesis of cobalt nanoparticles and carbon nanotubes directly on conductive substrates are of special interest since it allows the fabrication of quasi one-dimensional hybrid systems with tunable properties and a wide range of applications in nano and microelectronics, spintronic and magnetic information storage. Since metals are high-surface energy materials, it is difficult to stabilize metal nanoparticles for nanotube growth directly on metal surfaces. In this work we present a simple and reliable fabrication approach to produce controlled Co magnetic nanoparticles by solid state dewetting of metal films deposited on a conductive substrates acting as barriers. Indeed, refractory conductive films such as titanium silicon nitride TiSiN were proposed as barriers to limit catalyst diffusion into the bulk of the substrate. In addition, the low surface energy of TiSiN favors catalyst de-wetting, thereby improving nanotube forest density and verticality. Titanium silicon nitride films were first deposited on silicon wafers by thermionic vacuum arc. Then, ultra-thin cobalt films with thickness up to 3 nm were deposited on the top of TiSiN; the dewetting process of the cobalt films was achieved by thermal heating followed by plasma treatment. After these steps, the initial continuous layer breaks up into isolated nanoparticles. Finally, carbon nanotube grow by methane decomposition on the cobalt nanoparticles by using plasma enhanced chemical vapor deposition (PECVD) reactor. In particular, the microscopic analysis showed that the density and the size of the generated nanoparticles depend on the thickness of the deposited cobalt films as well as the control of thermally activated processes mainly bulk diffusion. On the other hand, the magnetic properties measurements confirmed that the design of nanoparticles and their size distribution control their coercitive field. In this direction, high-ordered self-organized cobalt/nanotube hybrid systems could be proposed as functional nanostructured elements in magnetic information storage devices.

Recent Publications

1. **Rousseau O, et al., (2017) Elaboration and magnetic properties of cobalt-palladium magnetic nanowires encapsulated in carbon nanotubes. Journal of Surface Engineered Materials and Advanced Technology 7(1):1-12.**
2. **Chen G, et al., (2016) A sweet spot for highly efficient growth of vertically aligned single-walled carbon nanotube forests enabling their unique structures and properties. Nanoscale 8(1):162-71.**
3. **Marco Altomare N T N and Patrik Schmuki (2016) Templated dewetting designing entirely selforganized platforms for photocatalysis. Chemical Science 7:6865-6886.**

Biography

A Andalouci studied Petrochemical Engineering at the Faculty of the Chemistry and Hydrocarbons, Algeria, in 2015, and he also obtained his Master degree in Physics of Material from University of Paris 13, France , in 2017. He is currently a PhD student in the PPANAM axe at the LSPM laboratory of the University Paris 13. His research interests include the synthesis and functionalization of carbon nanotubes and nanomaterials for microelectronic and magnetic applications.

andalouciahmed@gmail.com