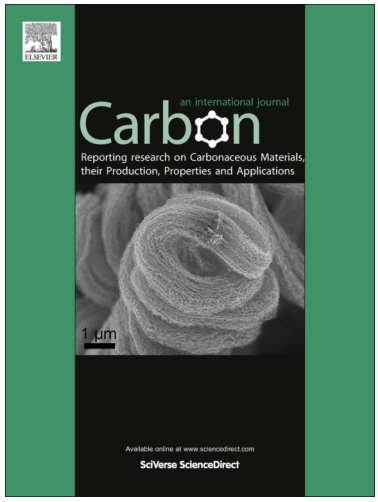

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Direct Growth of Hollow Carbon Nanorods on Porous Graphenic Carbon film without Catalysts

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Abstract

A method is developed for growing three-dimensional hierarchic structures of porous graphenic carbon film/ hollow carbon nanorods where porous graphenic carbon film is first synthesized followed by, growth of carbon nanorods. By annealing an amorphous carbon layer deposited underneath a nickel thin film at elevated temperatures, the porous graphenic carbon film forms on top via carbon diffusion and precipitation from the grain boundaries of the nickel film. The porosity of the graphenic carbon film is determined by the surface voids of the nickel film resulting from grain coalescence during annealing. Hollow carbon nanorods can then be grown on the pore edges of the porous graphenic carbon film by chemical vapor deposition without catalysts. It is speculated that the dangling bonds of the carbon atoms on the pore edges of the graphene layers might be responsible for the nucleation of the hollow carbon nanorods. The microstructures and growth mechanisms of both porous graphenic carbon film and hollow carbon nanorods are characterized and discussed in detail.