Synthesizing Carbon Nanotubes and Graphene via Carbothermal Reduction of SixOy

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Abstract

Metal free carbon nanostructures are desirable materials for wide potential applications in composites, drug delivery, electronic circuits, especially for the silicon industry. The general requirement for the silicon industry for metal free carbon nanotubes is well known. Metals reduce chip lifetime because they react unfavourably with many materials found in circuits. Hence, the use of non-metallic catalysts is desirable for silicon compatibility (and also composites). Recently various investigations have successfully implemented oxide catalyst particles, for example, SiO_2, ZrO_2, MgO or Al_2O_3. The use of SiO_2 as a catalyst for graphitic nanostructure formation, such as carbon nanotubes and graphene, is particularly attractive for integration into Si based technology. A key question is whether carbide phases form in the reaction. We show the formation of SiC from SiO_2 nanoparticles for the synthesis of graphitic carbon nanostructures *via* chemical vapor deposition (CVD) at 900°C. Our findings point to the carbothermal reduction of SiO_2 in the CVD reaction. Moreover, the inclusion of triethyl borate accelerates the carbothermal reduction process improving the availability of SiC species and hence leads to improved yields. The formation of graphitic carbon is best explained through a carbon dissolution mechanism. The studies improve our understanding of the growth mechanisms at play in sp^2 carbon formation when using SiO_2 catalysts.