

Abstract

A method capable of synthesizing carbon nanotubes at low cost and large quantities, an apparatus usable for carrying out the method, and carbon nanotubes densely aligned on and firmly bonded to a Si substrate over, and oriented perpendicular to, an entire surface thereof are provided. Highly oriented, aligned carbon nanotubes are synthesized from an organic liquid by forming a substrate with a buildup thereon of a thin film or fine insular particles composed of at least one metallic element; exposing the substrate (3) having the buildup to a hydrogen plasma; and heating the substrate (3) exposed to the hydrogen plasma in the organic liquid (10) to a predetermined temperature. The synthesis apparatus comprises: a liquid chamber or tank (1) for an organic liquid; a water cooling means (2) for cooling the liquid tank (1) from its outside; a substrate holder (5) for holding a substrate (3), the holder having electrodes (4) for passing an electric current through the substrate (3); a condensing means (7) comprising water cooling tubes (6) for cooling and condensing vapor made from the organic liquid by its vaporization to return it to the liquid for return into the liquid tank (1); a valve (8) through which N₂ gas is introduced; and a lid (9) that carries the substrate holder (5), the condensing means (7) and the valve (8). The organic liquid (10) is thus tightly sealed in the liquid tank (1) by the lid (9). This synthesis apparatus allows carbon nanotubes to be synthesized in large quantities, at low cost and in safety. Highly coaxially and densely oriented, aligned carbon nanotubes can be synthesized in the form of a bundle thereof, which when used in a variety of products brings about various excellent effects including extremely high usability.



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