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Review article | Nanoscience & Technology: Open Access | Open Access

# Carbon Nanotubes from Carbon Dioxide

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**Received: May 9, 2018; Accepted: May 17, 2018; Published: May 18, 2018**

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## Abstract

Green house gas emission particularly emission of $CO_2$ is a major issue in global warming. Numbers of methods are known to convert $CO_2$ into useful product. However, recently conversion of $CO_2$ into CNT is reported. The information is given in this short article.

## Introduction

Global warming and global climate changes are due to anthropogenic activities throughout the world [1]. Emissions of greenhouse gases particularly $CO_2$ gas are responsible for greenhouse effect [2]. $CO_2$ emissions by different sectors are given in

Figure 1 [3]. Surface temperature is increasing continuously. Therefore, there is an urgent need to develop technologies that will reduce $CO_2$ emissions.

The easiest way to reduce $CO_2$ concentrations is to reduce $CO_2$ emissions through cleaner and more environmentally friendly industrial processes. However, it is not possible in near future. However, there are many ways to reduce $CO_2$ by converting into number of useful products (Figure 2).

One of the most important nanomaterials is carbon Nanotubes, which can be made from $CO_2$. There are two types of carbon Nanotubes (Single and double walled carbon nanotubes) (Figure 3). Carbon Nanotubes (CNTs) have been extensively studied due to their unique mechanical, electronic, and thermal properties

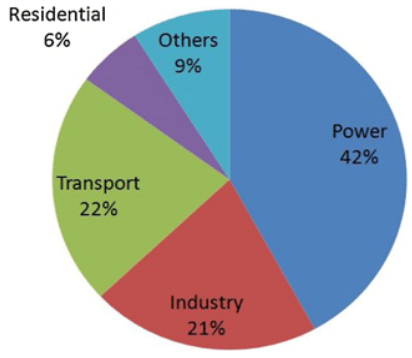


**Figure 1:** $CO_2$ emissions in 2011

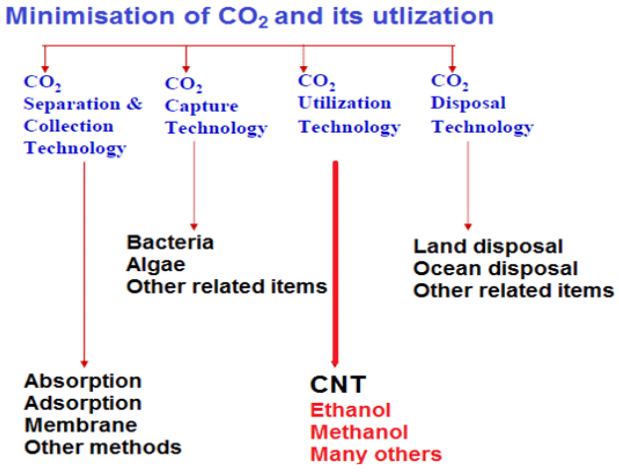


**Figure 2:** Utilization of $CO_2$

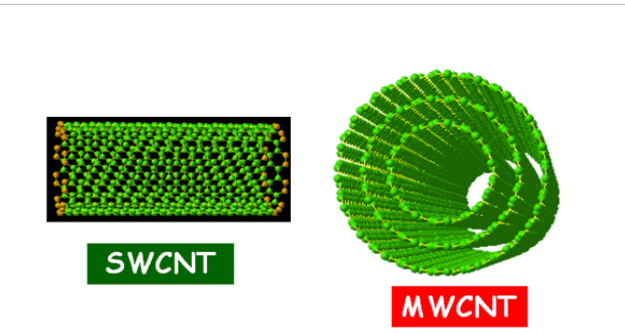


**Figure 3:** Carbon Nanotubes

There are number of methods for the synthesis of carbon Nanotubes but the most exciting and new is that by $CO_2$ [3]. Numerous $CO_2$ transformation strategies have been proposed to produce CNTs, porous carbon, and graphene using supercritical $CO_2$ or dry ice [4,5,6].

$Li_2CO_3$ with trace concentrations of Ni, Cu, Fe or Co dissolve $CO_2$ to produce CNTs. Figure 4 shows a two chamber where electrolysis and $CO_2$ dissolution occurs [7,8].

CNTs production by electrolysis in lithium carbonate occurs with the production of oxygen and lithium oxide:

$Li_2CO_3$ (liquid) ® C (CNT) + $Li_2O$ (dissolved) + $O_2$ (gas) (1)

$Li_2CO_3$ consumed in Eq.1 is continuously compensated by

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Eq.2.

$Li_2O$ (dissolved) + $CO_2$ (gas) ® $Li_2CO_3$ (liquid) (2)

Net reaction (combining Eqs (1) and (2)):

$CO_2$ (gas) ® C(CNT) + $O_2$(gas)

Thus from the above reactions $CO_2$ produced is continuously being consumed to give CNT. This is entirely new and novel process for converting $CO_2$ into CNT. If this process is commercialized, there will be a breakthrough in global warming.

CNT synthesized using $CO_2$ is shown in Figure 5 [7,8].

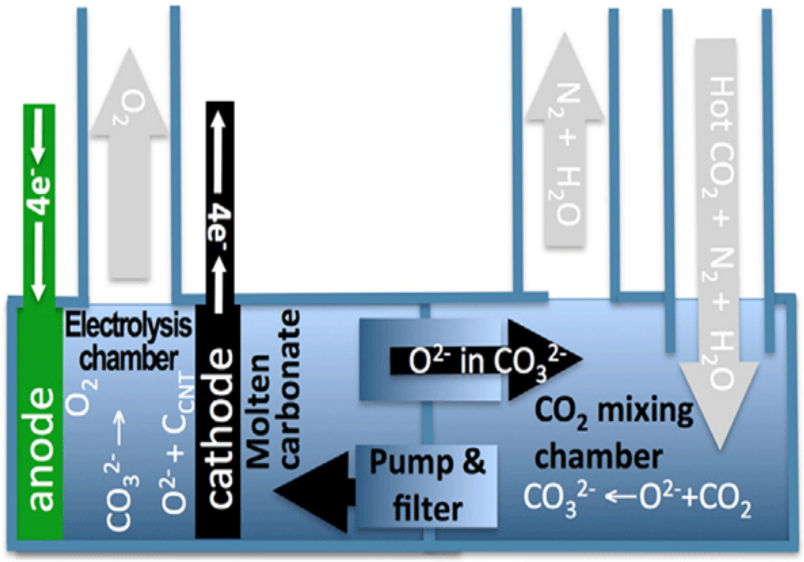


**Figure 4:** $CO_2$ to CNT transformation

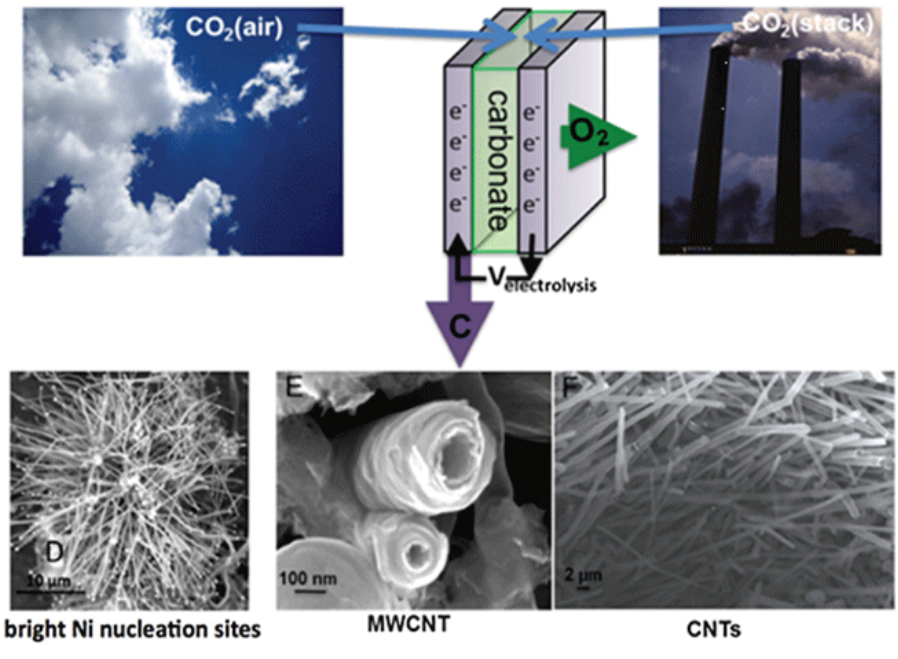


**Figure 4:** Synthesis of carbon nanotubes from $CO_2$ in molten lithium carbonate.

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