**CARBON DIOXIDE UTILIZATION BY GRAPHENE BASED NANOCOMPOSITE MATERIALS AS CATALYSTS**

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**EXTENDED ABSTRACT**

Carbon dioxide (CO2) has recently become the focus of global attention because of the position of CO2 as the primary greenhouse gas and the implication of its emissions on the problem of climate change. Fossil fuels emit CO2 in vast quantities and efforts are required to reduce emissions of greenhouse gas to prevent catastrophic climate change. Utilisation of renewable, non-toxic and inexpensive raw material such as CO2 to synthesise valuable chemicals, e.g. organic carbonates is a prerequisite for sustainable environment and greener chemical process.

Organic carbonates, such as propylene carbonate (PC), dimethyl carbonate (DMC), 1,2-butylene carbonate (BC) have widely been used as intermediates in the synthesis of chemicals, pharmaceuticals and fuel additives. The conventional method of PC synthesis employs homogeneous catalysts and toxic raw materials including phosgene and *iso*-cyanates. Hence, there is a need for an environmentally benign greener process for the synthesis of PC from CO2. DMC has excellent chemical properties, which make it a very good precursor material for the production of polycarbonates and a potential gasoline additive due to its high oxygen content. DMC can be synthesised at industrial scale *via* methanolysis of phosgene and oxidative carbonylation of methanol (MeOH). However, both routes have their shortcomings; the methanolysis route uses phosgene, which is a very toxic chemical and produces hydrochloric acid as a by-product and the oxidative carbonylation route uses hazardous carbon monoxide. Therefore, considerable efforts have gone into the development of an environmentally benign process for the production of DMC. Direct synthesis of DMC from MeOH and CO2 using heterogeneous catalyst is the most attractive route due to the inexpensive raw materials and the avoidance of corrosive reagents.

Continuous hydrothermal flow synthesis (CHFS) has been employed as a rapid and cleaner route for the synthesis of highly efficient and novel graphene based inorganic heterogeneous catalyst, e.g. Ce–Zr oxide/graphene and Ce–Zr–La oxide/graphene nanocomposites. Ce–Zr–La oxide/graphene nanocomposite was synthesized from pre-mixed aqueous solution of cerium, lanthanum, zirconium nitrate and graphene oxide (synthesized *via* conventional Hummers method) under alkaline conditions using the CHFS reactor. The resulting nanocomposite catalyst was heat-treated at various temperatures (e.g. 773, 973 and 1173 K) and their catalytic properties were assessed. The as-prepared and the corresponding heat treated catalysts have been extensively characterized using powder X-ray diffraction (XRD), transmission electron microscopy (TEM), scanning transmission electron microscopy (STEM), Brunauer–Emmett–Teller (BET) surface area measurement and X-ray photoelectron spectroscopy (XPS) analysis. The presentation will discuss detailed synthesis and application of graphene based nanocomposite materials as heterogeneous catalysts for organic carbonates syntheses. The experimental findings indicate that graphene based nanocomposite materials have a huge potential as heterogeneous catalysts for the synthesis of organic carbonates.