# Greener synthesis of styrene carbonate from $CO_2$ using graphene-inorganic nanocomposite catalysts

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The global emission of carbon dioxide ($CO_2$) into the atmosphere has reached an unsustainable level that has resulted in climate change and therefore there is the need to reduce the emission of carbon dioxide. However, the reduction of $CO_2$ emission has become a global environmental challenge and the use of $CO_2$ to produce value added chemicals could be one of the few ways of reducing $CO_2$ emission. $CO_2$ is recognised as an abundant, cheap, recyclable and non-toxic carbon source and thus its utilisation for the production of value-added chemicals is extremely beneficial for the chemical industry.

Styrene carbonate is a valuable chemical of great commercial interest. It is an excellent precursor material for the production of polycarbonates and can be used as a solvent for lithium battery because of its high polarity property. Several reaction routes have been attempted for styrene carbonate production, which was phosgene, oxidative carboxylation, direct synthesis using homogeneous catalyst and direct synthesis using a heterogeneous catalyst. The latter being the most attractive route due to the inexpensive raw material, ease of catalyst recovery and the avoidance of corrosive reagents, such as phosgene and dimethyl formamide.

Continuous hydrothermal flow synthesis (CHFS) has been employed as a rapid and cleaner route for the synthesis of highly efficient graphene-inorganic heterogeneous catalyst, represented as Ce–La–Zr–GO nanocomposite. The graphene-inorganic heterogeneous catalyst has been characterised using transmission electron microscopy (TEM) and X-ray photoelectron spectroscopy (XPS), while X-ray powder diffraction (XRD) and Brunauer–Emmett–Teller (BET) methods have been used for the surface area measurements.

Ceria, lanthana, zirconia doped graphene nanocomposite catalyst studies have shown high catalytic activity as compared to other reported heterogeneous catalysts in the absence of organic solvent with a higher selectivity of 68% and 60% yield of styrene carbonate at the reaction conditions of 408 K, 75 bar in 20 h.

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