Catalytic Carbonization of Biomass to 2D Carbon Materials

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Advanced Carbon materials like Carbon fibers and Carbon foams are seen as the ideal future materials to replace high CO_2 intensity metals and/or non-recyclable plastics because of their remarkable strength, low weight and ease to be reused (recycled). Unfortunately, the cost to produce these advanced materials is still very high which forms a significant barrier to their large-scale application.

At present premium 2-D Carbons like Graphene and Graphene oxide are produced from natural graphite via an elaborate process whereby first the graphite is oxidized via the "Hammer" procedure. Next the Graphite oxide (± 50% O2) produced is exfoliated and reduced to Reduced Graphene Oxide (± 20% O2) or Graphene. The processes described are precarious and costly and the 2D materials produced contain a significant number of defects because of the severe conditions applied. Furthermore,

Several alternatives have been developed like the thermal carbonization of hydrocarbons and/or biomass. Examples are the flash or plasma pyrolysis of Methane and/or biomass waste. The temperatures required for the conversion to Carbon are high and the resulting yield of Carbon is low (The % Carbon of the feed recovered as Carbon product is below 30%wt). A lot of other side products are also produced which need to be recovered and used: often combusted forming extra CO_2.

To address these drawbacks Catalytic processes have been developed to convert Methane and other hydrocarbons and biomass waste. Catalyst used are molten metals and/or heterogeneous catalysts containing metals for instance Nickel and/or Iron. Unfortunately, also this approach has several drawbacks: First, the effective contact between the reactants (Methane and/or solid biomass) and catalyst, hence the accessibility of the active sites is limited. Secondly it is difficult to separate the Carbon formed from the molten metals and/or the solid heterogeneous catalyst resulting in a deterioration of the performance over time and a poor recovery of the Carbon product.

The CarbonPlus technology employs a molten salt/molten salt hydrate as catalyst system which enables an excellent mixing and a very high accessibility of the reactants with the molten salt catalyst and allows for a good separation of the Carbon product resulting in a high Carbon recovery and is easy method to regenerate and reuse the catalyst.

The resulting Carbon yield is high (The % Carbon of the feed recovered as Carbon product is above 75%wt). And because of the milder operating conditions (lower temperatures and times) the 2D Carbon produced exhibits a lower number of defects.