

Layered Nanosheet Materials as Advanced Catalyst Systems

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Friday, April 11th 2014

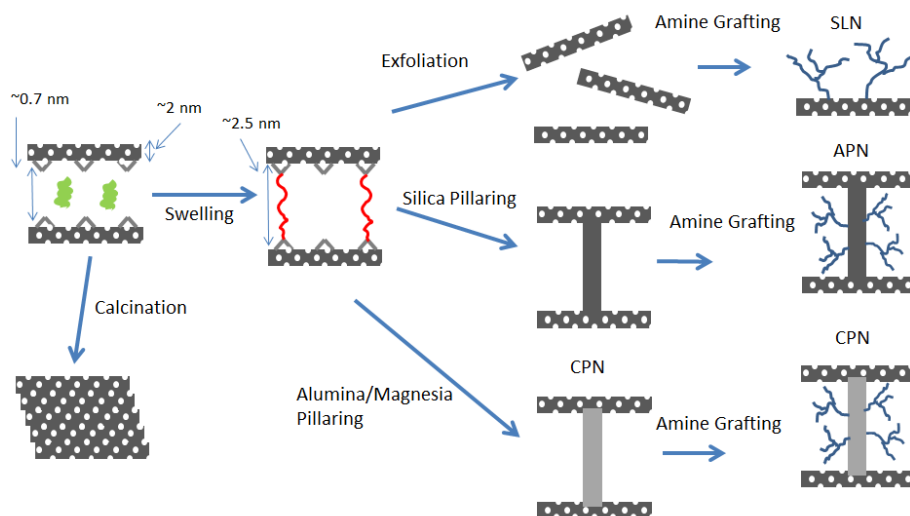
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The efficient capture and conversion of carbon dioxide is currently an issue which has received a lot of attention from researchers working in the energy and environmental engineering fields. However, up to this point no system which allows for the efficient removal and conversion of carbon dioxide in high yields from both atmospheric and flue gas streams has been developed. Liquid capture systems, such as the liquid amine systems used industrially, can capture carbon dioxide but require high energy inputs to regenerate and have low capture efficiencies. Furthermore these materials have not been shown capable of both capturing and converting carbon dioxide in a single integrated system. In order to overcome these challenges, while retaining the positive aspects of amine capture systems such as high selectivity, solid porous adsorbents which have been functionalized with amines for capture are being researched. While these systems in general have low regeneration energy requirements and can be loaded with amines to retain high capture capacity and selectivity, there is often a clogging of the pore space caused by the amine loading. This makes it more difficult for the carbon dioxide to diffuse through the material, and thereby greatly reduces the overall ability of the material to efficiently capture carbon dioxide.

The creation of a material which retains the high specific surface areas and porosity of solid adsorbents, as well as having the ability to be functionalized for carbon dioxide capture and conversion while retaining high accessibility throughout the porous channels is therefore a large goal for the research community. For this study, we are investigating Layered Nanosheet materials and other lamellar structured material derivatives for this purpose. These materials are

generated from layered nanosheet precursors such as MCM-22-P and AMH-3, which can be swollen, pillared, and functionalized with amine containing molecules to create a final material with all of the requirements for efficient carbon dioxide capture and conversion. A diagram of this process is shown below.



The creation of a number of novel materials will be proposed in this work, through the utilization of the unique chemical and physical properties of layered nanosheet precursor materials. Amino-Pillared derivatives (APNs) will be generated by the introduction of amine groups onto the pillared structure. Catalytically active pillars (CPNs) will be generated by the creation of novel metal pillars and the introduction of nanoparticles onto the layer surface. Single layered derivatives (SLNs) will be generated by the attachment of the individual sheets into a larger framework by the grafting of a polymer backbone to the sheet surface, and subsequent polymerization to attach these sheets together into a larger gel network.