ROLE OF ORGANOMETALLIC CHEMIST IN THE 21ST CENTURY TO MITIGATE CO_2 LEVEL IN THE ATMOSPHERE

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In the 21st century, one of the biggest problems faced by the world today is the rapid increase of the CO_2 level in the atmosphere. There are only a few natural sources such as plants which can absorb CO_2 and control the equilibrium of the atmosphere, but the number of sources that emit CO_2 to the atmosphere are more than the natural sources present to absorb it. Therefore the elevated level of CO_2 causes several detrimental effects such as greenhouse effect, acid rains, melting of glaciers and health issues such as lung diseases and cancers. Comparing to the other pollutants, CO_2 plays a significant role in air pollution. Green plants trap CO_2 by the photosynthesis in the day time and emit O_2 in to the atmosphere; this process will keep the balance of O_2 and CO_2 level in the air. In early 60's evaluation of the industrial age, diesel engines began to produce more CO_2 and CO in to the atmosphere, and at the same time deforestation and the use of diesel as a fuel made the air pollution worsen.

When the situation became critical, scientists tried to find out solutions for mitigating the environmental pollution caused by CO_2. Now many scientists are making efforts to find out solutions to mitigate CO_2 level in various ways. Here not only by natural ways but also some synthetic complexes similar to Chlorophyll is being synthesised (Srivastava, 2005; Peiris and Ganehenege, 2011(a); Peiris and Ganehenege, 2011(b); Peiris and Ganehenege, 2012) to do the same role that chlorophylls do in plants. In this context, synthetic inorganic chemists started the synthesis of transition metal macrocyclic complexes that can act as a catalyst similar to the natural sources. As a first attempt, researchers in our group (Dr. M. Y. U. Ganehenege and her research group) attempted to substitute Mg^{2+} centre of isolated chlorophyll (Figure 01) by transition metal ions and subsequent utilization of such complexes for efficient CO_2 binding (Gurusinghe, 2010).

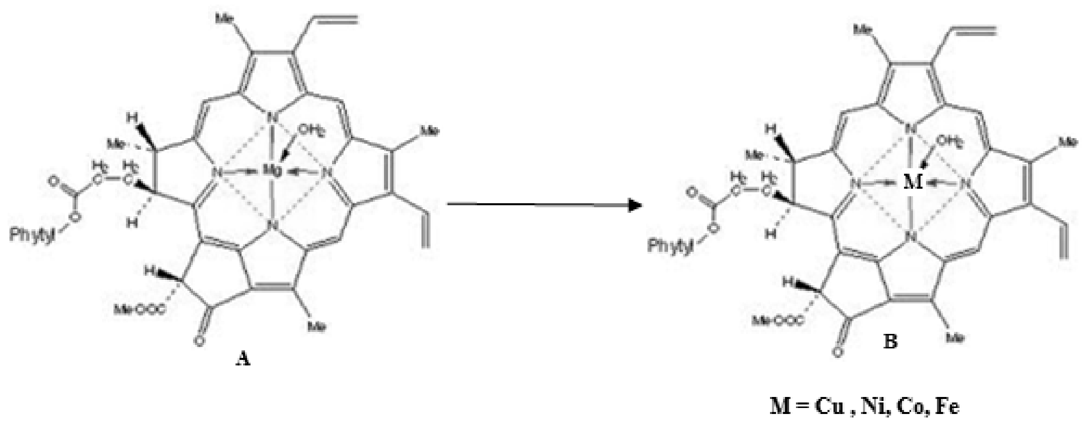
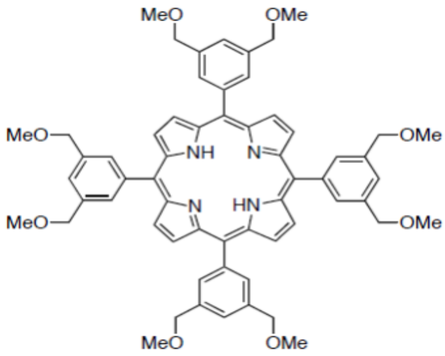


Figure 01: Chemical structure of the chlorophyll (A) and modified chlorophyll with transition metal ions (B).

However, in early days researchers attempted to synthesis the structures similar to chlorophylls artificially. For an example porpyrins and metalloporpyrins synthesis have been achieved by the "Adler and his research group" in 1966 (Adler *et al.*, 1967). Since then the porpyrin as well as pthalocynin (Figure 02) synthesis have been come along a long way with modifications to achieve many targets. Most of the complexes are nearly similar to the chemical and physical properties of chlorophyll.



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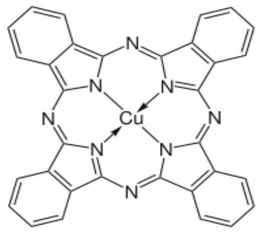

B

Figure 02: Structures of synthetic porpyrin ligand (A) and metal pthalocynin complex (B).

After synthesis of several types of macrocyclic complexes, next step was to use them as a catalyst to reduce CO_2. In here electrochemical reduction and photochemical reduction are the widely used methods. From these two methods, environmental friendly method is the photochemical reduction. The electrochemical method is efficient although it is expensive. Nevertheless, the final electrochemical product can be evaluated by using bulk electrolysis and spectroelectrochemical techniques. Therefore in the near future scientist may achieve CO_2 reduction by modifying efficient transition macrocyclic catalysts, to reduce CO_2 in to useful products such as formic or bicarbonic acid while reducing the CO_2 level in the atmosphere significantly. Not only porpyrin complexes, but also many organometallic complexes, schiff base complexes and metal macrocylic complexes have been reported to catalyse many electrochemical and photochemical transformations of CO_2 (Srivastava, 2005). Nowadays, the mitigating of CO_2 has become the turning point of the green chemistry in sustainable development.

References:

Adler, A.D., Longo, F.R., Finarelli, J.D., Goldmacher, J., Assour, J. and Korsakoff, L. (1967). A simplified synthesis for meso-tetraphenylporphine. *The Journal of Organic Chemistry*, *32*(2), 476-476.

Gurusinghe, R. and Ganehenege, M.Y.U. (2010). Synthesis and CO_2 binding / reduction studies of Iron substituted Chlorophylls. Abs. *Peradeniya University Research sessions*: University of Peradeniya, Sri Lanka.

Peiris, M.C.R. and Ganehenege, M.Y.U., (2012). Synthesis of [1,4,8,11-tetraaza-5,7,7,12,14,14-hexamethyl tetradeca-4,11-diene] Cu(II) macrocyclic complex, determination of its anion association and capability of electrocatalytical reduction of CO_2**.** Abs*. International conference on chemical sciences*: Colombo, Sri Lanka.

Peiris, M.C.R. and Ganehenege, M.Y.U. (2011 (a)). Synthesis of Copper(II) Complex of [5, 12-dioxa-7, 14-dimethyl-1, 4, 8, 11-tetraazacyclotetradeca-1, 8-diene (L)] and determination of its CO_2 binding properties. Abs*. Peradeniya University Research sessions*: University of Peradeniya, Sri Lanka.

Peiris, M.C.R. and Ganehenege, M.Y.U. (2011 (b)). Determination of CO_2 and SCN^- binding capacities of [5, 12-dioxaa-7, 14-dimethyl-1, 4, 8, 11-tetraazacyclotetradeca-1, 8-diene (L)] Co(II) complex. Abs*. Peradeniya University Research sessions*: University of Peradeniya, Sri Lanka.

Srivastava, R., Bennur, T.H. and Srinivas, D. (2005). Factors affecting activation and utilization of carbon in cyclic carbonate synthesis over Cu and Mn macrocyclic complexes, *Journal of Moleculer Catalysis,* 226, 199-205.