Low-cost nanocatalysts for the electrochemical CO_2 reduction to valuable products

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Greenhouse Gases emission control is one of the most challenging environmental issues to face in the 21st century. The electrocatalytic CO_2 reduction is a interesting technology because, driven by renewable energy sources, can be used to store both renewable electricity and CO_2 in valuable products such as syngas (CO and H_2 mixtures), organic acids (like formic acid) and/or liquid fuels (methanol or > C_1 products with a higher energy density).[1] However, the main challenge is to find a suitable electrocatalyst to establish this technology at industrial level. For the syngas production, the most conmonly used catalyst are based on noble metals like silver (Ag) and gold (Au).[2] In our group, we have developed a low-cost Ag-based catalyst by dispersing Ag nanoparticles in the top of TiO_2 nanotubes (NTs).[3] This new material shows a higher electrochemical surface area and electrons transport than bare Ag foil and Ag on TiO_2 nanoparticles; moreover, TiO_2 can be used as an efficient support for metal catalysts because it enhance the stability of key $CO_2^{\cdot-}$ radical intermediate formation, decreasing the CO_2 electroreduction overpotential. On the other hand, we are exploiting the curent knowledge of the thermocatalytic CO_2 hydrogenation to make faster progress in the development of an optimal electrocatalyst for the CO_2 electrochemical reduction. For instance, when Cu/Zn/Al-based catalysts are tested for these two processes different products can be produced under their respective optimun operative conditions (*i.e.* high H_2 partial pressure (P) and temperature (T) > 200 ^oC for the thermocatalytic CO_2 reduction, while atmospheric T and P are used in the electrocatalytic one). While the thermocatalytic process induces the production of methanol and CO, the electrocatalytic one generates H_2, CO as well as other C-containig liquid products (from C_1 to C_3). In conclusion, we have developed low-cost nanostructures catalysts able to produce syngas with a tunable composition (depending on the applied potential) and other liquid C_{2+} products thorugh the electrochemcial CO_2 reduction at ambient T,P. These results pave the way to the implementation of novel nanostructured materials towards the development of a highly sustainable and economic technology for the CO_2 conversion to the fuels of the future.

References

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