# Graphene applications to PEM fuel cell technology

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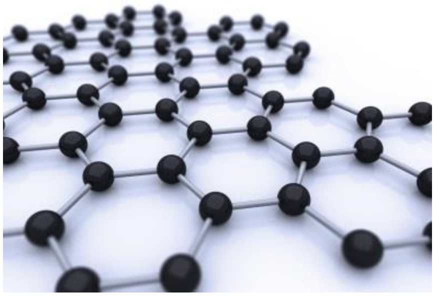

**Figure 1.** Graphene sheet structure.

Graphene is a two-dimensional carbonaceous material that is structured in layers of carbon atoms with a sp2 hybridization forming a hexagonal network. This material, due to its properties of high electrical conductivity, flexibility, thermal stability, mechanical and high surface, among others, is of great interest in various scientific fields: physics, chemistry, electronics, biology, etc. Its potential for application is huge, so in recent years numerous developments have been developing that open new perspectives in the progress of different technologies.

Specifically, its application in the field of energy conversion or storage devices is relatively recent, although it grows progressively and at high speed. In the field of proton exchange membrane fuel cells (PEMFC), its application has been considered primarily for the synthesis of catalysts. Graphene functionalized with heteroatoms has shown a high electrocatalytic activity for the oxygen reduction reaction. On the other hand, graphene nanoparticles have very promising applications as a two-dimensional catalytic support. It's extremely high specific theoretical surface area (≈2600 $m^2 \cdot g^{-1}$), its excellent electrical, mechanical, thermoconductive properties, the possibility of creating interlinear functional groups and defects for the anchoring of particles, or the strong interaction with metals make of this material a potentially ideal support for electrocatalysts [1]. More recently, it has been applied as surface coating for corrosion protection [2, 3]. This property can be used in the fuel cells to protect the current collector plates, grids, or flow field plates without producing contaminating corrosion products.

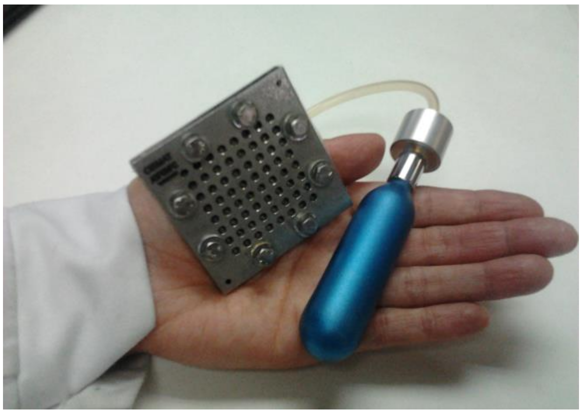

**Figure 2.** Air-breathing proton exchange membrane fuel cell (PEMFC)

The control of the hydrophilic and hydrophobic properties of these coatings is another point of interest to consider, since water management is a key point for the operation of a PEMFC. The rapid evacuation of the water generated in the electrodes is a basic premise to improve the transport of matter in the electrodes. The application of graphene structures with controlled wetting properties can be a tool of interest for the adequate distribution of the water in the fuel cell with a material of high chemical compatibility, which in turn does not resist resistance to the passage of the generated current.

## Experimental approach

The formation of graphene films from graphene oxide is going to be studied by reaction with copper as substrate to induce GO platelets self-assembly. The study takes into account the modification of several variables: i.e. the pH, reaction time, temperature and GO concentration. This procedure is compared to other methods for graphene films formation, such as the reduction of graphene oxide films with hydrazine or with a $CO_2$ laser beam. The obtained film are analyzed by different techniques for their characterization.

## Results and conclusions

The control of the conditions for the reduction and self-assembly of the GO platelets using copper substrates allows the formation of graphene films on the surface of copper that are extended to void areas creating a graphene web. The corrosion protection properties of these films and their affinity with water are evaluated to be used in high performance components for PEMFCs. The results show that improvements in water management and corrosion protection are shown to be of interest in this field.

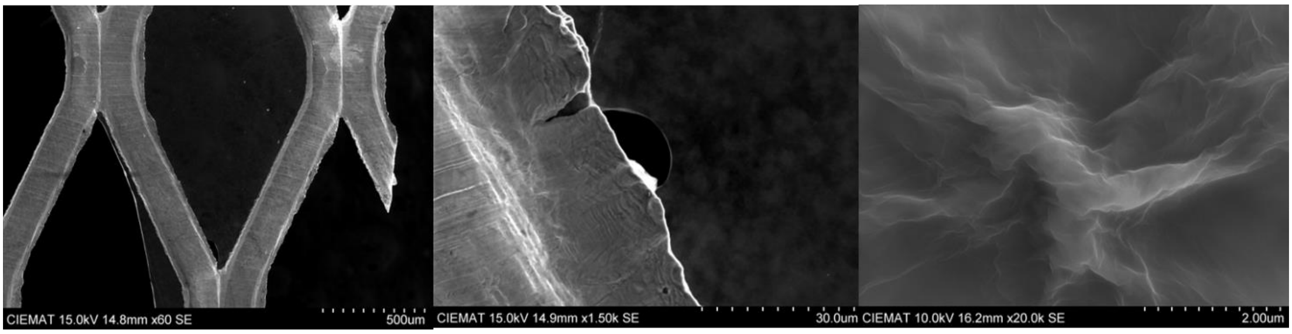


**Figure 3.** Graphene film formed on a copper expanded microgrid. The images were taken by SEM at different points in the sample.

## Acknowledgements

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## References

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