Insights into permeation properties of GO and rGO films.

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INTRODUCTION

Graphene materials are recently finding very interesting applications in innumerable technological fields as result of their particular properties [1]. Membrane technology is one of these fields of interest, in particular for graphene oxide (GO) and reduced graphene oxide (rGO).

Reduced GO membranes have been reported to allow unimpeded permeability to water, whereas they can be leak tight to gases such as helium [2]. The permeation properties of GO and rGO membranes have been evaluated and are presented in this study together with their morphological and physicochemical characterization.

EXPERIMENTAL STUDY

Graphene oxide (GO) and reduced graphene oxide (rGO) membranes have been prepared from aqueous GO dispersions (Graphenea). The membranes have been prepared from solutions containing GO in a concentration of 4mg/mL. A small volume was deposited on a hydrophobic surface and dried at room temperature in order to obtain self-supported graphene oxide films (GO). These films were submitted to different treatments of heating and/or chemical reduction using an environmentally friendly reductant such as ascorbic acid. The resulting membranes were characterized by scanning electron microscopy, X ray diffraction, attenuated total reflectance Fourier transformed infrared (ATR-FTIR) spectroscopy and X ray photoelectron spectroscopy (XPS) and their permeability properties for gases and other fluids analyzed.

RESULTS AND DISCUSSION

The morphology and properties of the membranes are largely dependent on both the thermal treatment and the reduction degree of the GO film, as it can be observed in Fig. 1. Those membranes have been prepared with the same amount of GO per square centimeter. They are conformed by stacked layers of GO platelets, showing a "millefeuille"-like architecture, but their thicknesses are greatly dependent on the drying temperature and the reduction treatment.

XRD results reveal the complete absence of GO peaks in the GO-AA sample, and, although they are substantially reduced by heating at 150ºC, they are still distinguishable for GO-150ºC. The expanded volume observed for the cross-sections of the samples submitted to thermal or chemical reduction processes contrasts with the reduced thickness of the combined subsequent treatments: i.e the GO-150ºC-AA membrane, for which less than 2 µm were measured. The permeability of these samples will be discussed in the light of the characterization results.

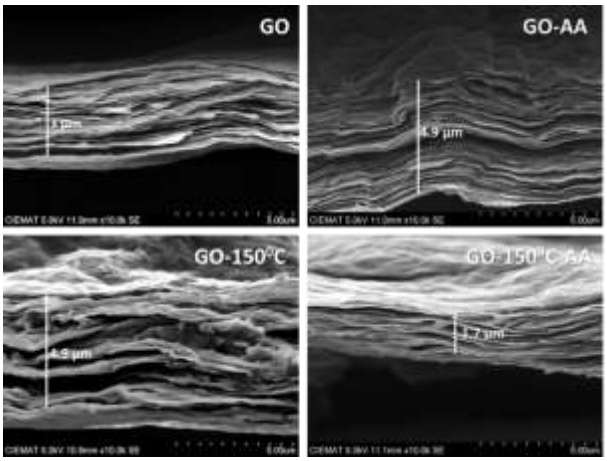

Fig. 1 SEM micrographs obtained for cross-sections of GO self-supported membranes submitted to different treatments: GO: as prepared by dispersion evaporation at room temperature; GO-AA: submitted to reduction at 50ºC in ascorbic acid solution; GO-150ºC: dried at 150ºC after evaporation at room temperature; GO-150ºC-AA: submitted to reduction in ascorbic acid solution at 50ºC after drying at 150ºC.

CONCLUSION

GO and rGO self-supported membranes have been synthesized, characterized and tested for gas permeation. The results indicate that thermal and reduction treatments have a great impact on the structure and properties of these films.

REFERENCES

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ACKNOWLEDGMENTS

The authors acknowledge the Ministry of Economy and Competitiveness and the Social European Fund for funding under the E-LIG-E project (ENE2015 70417-P) and the grant BES-2016-077336.