# Report on the outcomes of a Short-Term Scientific Mission[1]

**Action number:** CA20126

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## Details of the STSM

**Title:** Characterization and testing of spent brewery grains-adsorbent materials

Start and end date: 17/10/2022 to 28/10/2022

## Description of the work carried out during the STSM

The main objective of the internship was to know the areas of research developed in the Instituto para Ciência y Tecnología del Carbono (INCAR). Initially, the main laboratories, equipment and the research group's staff were presented. In recent years, the group has focused on the adsorption of $CO_2$ at low temperatures from different gas mixtures in gas phase aimed at the production of $H_2$ through Sorption Enhanced Steam Reforming (SESR). This study uses a biomass and or a catalyst to achieve equilibrium through capture and $CO_2$ and $H_2$ production, achieving conversion rates of up to 90%. To achieve this objective, some equipment was introduced such as: degasified, equipment for partial combustion to capture $CO_2$ through the use of biomass and release of $H_2$. Micromeritics Instrument to perform $N_2$ isotherms and the thermobalance (thermogravimetric analysis), applied to measure the $CO_2$ capture capacity of the materials by isotherms models. A full work consists of producing the materials, evaluating the $CO_2$ adsorption kinetics, characterizing the textural properties, evaluating the water vapour adsorption behaviour, and evaluating the adsorption-desorption cycles of the materials. The work carried out during the two-week internship will be next described:

Description of work:

The objective of this STSM was the study of the adsorption capacity of the activated carbons adsorbent materials synthetized from brewery industry. These materials were assessed for $CO_2$ capture from different gas mixtures and, $N_2$ isotherms to calculate the specific surface area through BET analysis. The experimental work includes the textural characterization of the materials by means of the $CO_2$ adsorption isotherms and evaluation of the capture capacity through thermogravimetric analysis. The $CO_2$ adsorption capacity were compared with commercial adsorbents and with activated carbons previously tested in the group.
The $CO_2$ capture through textural analysis consisted of degassing the tubes for 4h, weighing the tubes, weighing the materials, degassing the tube with material overnight and then weighing again and writing the final mass to be registered into the software.
For the BET analyses for $N_2$ adsorption, the samples were weighed, the values and parameters were entered into the software and the samples were degassed for at least 12h. After that, the equipment was supplied with liquid

[1] This report is submitted by the grantee to the Action MC for approval and for claiming payment of the awarded grant. The Grant Awarding Coordinator coordinates the evaluation of this report on behalf of the Action MC and instructs the GH for payment of the Grant.

nitrogen. The samples testes in this study were named as AC-SBG (activated carbon produced from brewery wastes) and AC-O (activated carbon functionalized with oxygen groups).

## Description of the STSM main achievements and planned follow-up activities

In terms of specific surface area ($S_{BET}$), the values determined for AC-SBG (1069 $m^2\ g^{-1}$) and AC-O (1001 $m^2\ g^{-1}$) were comparable. The other textural properties also showed similar results, such as pore volume for $p/p^0$ less than 1, was 0.52 $cm^3\ g^{-1}$ and 0.49 $cm^3\ g^{-1}$ for AC-SBG and AC-O, respectively. The BET values were particularly higher than other absorbents, such as commercial activated carbon (929 $m^2\ g^{-1}$), frequently reported in the literature (Silva et al. (2021).

For textural characterization by using $CO_2$ adsorption, the quantity adsorbed (mmol $g^{-1}$) by waste-based AC and AC-SBG were 1.44 and 1.25 cm3 g-1, respectively. The micropore volume was 0.48 and 0.43 $cm^3\ g^{-1}$, respectively. These values were adjusted by using Dubinin-Radushkevich equation.

Comparing $CO_2$ adsorption capacity of the carbon foam at 0 °C with other adsorbents produced by INCAR (Moussa et al. 2022). The results here obtained were satisfactory. However, it is necessary an optimization in the production aim the decrease in the microporous volume to achieve optimum values lower than 0.2 $cm^3\ g^{-1}$.

Reference

Silva, C.P., Jaria, G., Otero, M., Esteves, V.I., Calisto, V., 2019. Adsorption of pharmaceuticals from biologically treated municipal wastewater using paper mill sludge-based activated carbon. Environ. Sci. Pollut. Res. 26, 13173–13184. https://doi.org/10.1007/s11356-019-04823-w.

Moussa, M., Bohli, T., Pevida, C., Querejeta, N., Ouederni, A., 2022. Olive stones based carbon foam: synthesis, characterization and application on post-combustion CO2 adsorption. J. Porous Mater. 29, 1097–1112. https://doi.org/10.1007/s10934-022-01240-2