Role of Surface Wettability on Interfacial Phenomena

Ferrario Michela[1], Minguzzi Alessandro[1], Vertova Alberto[1], Meroni Daniela[1]

[1]Università degli Studi di Milano, Italy

Modified wettability allows significant performance enhancements in materials and devices without changing their bulk composition, making it an attractive and cost-effective strategy for optimizing device efficiency [1]. This work aims to study the role of wettability of carbon materials, ranging from hydrophilic to superhydrophobic states, on the performance of electrodes for Oxygen Reduction Reaction (ORR).

The studied carbons were Vulcan XC72 (Cabot Corporation), Acetylene Black Y70 and Acetylene Black YS (Orion Engineered Carbons). The morphological properties of the powders were investigated through Dynamic Light Scattering (DLS) and Brunauer-Emmett-Teller analysis (BET). The sorption properties of the samples were studied by kinetic studies on tablets [2], and the wetting behaviour was determined on films using different solvents (ultrapure water, KOH, HCl and KCl concentrated solutions). The influence of Nafion on the morphological and wetting properties of the films was also studied.

Cyclic Voltammetry was used to study ORR using Rotating Ring Disk Electrode loaded with carbon. The electrochemical tests also included Double Layer Capacitance determination, H_2O_2 unwanted production and kinetic study with the application of Levich equation.

The results highlighted that the surface wetting has a notable effect on the extent of the three-phase contact line which affect the number of electrons transferred and improved performances can be obtained for a specific range of contact angle values, characteristic of an intermediate behaviour between Wenzel and Cassie-Baxter regimes.

As final step, the properties of bare Vulcan XC72 and Pt/Vulcan XC72 at different wettability were evaluated with Zeta-potential, DLS and electrochemical tests. Results confirm the obtained trends and performances highlighted on carbons.

[1] L. Zhao, Y. Li, M. Yu, Y. Peng, F. Ran, Advanced Science 10 (2023).

[2] S. Farris, L. Introzzi, P. Biagioni, T. Holz, A. Schiraldi, L. Piergiovanni, Langmuir 27 (2011) 7563–7574.