Hydrogen peroxide is a commodity chemical, as it is an environmentally friendly oxidant. The electrochemical production of \( \text{H}_2\text{O}_2 \) from oxygen and water by the reduction of oxygen is of great interest, as it would allow the decentralized, on-site, production of pure \( \text{H}_2\text{O}_2 \). The ability to run the reaction in an acidic electrolyte with high performance is particularly important, as it would allow the use of polymer solid electrolytes and the production of pH-neutral hydrogen peroxide.

Carbon catalysts, which are cheap, abundant, durable and can be highly selective show promise as potential catalysts for such systems. In this work, we examine the electrocatalytic performance and properties of seven commercially available carbon materials for \( \text{H}_2\text{O}_2 \) production by oxygen electroreduction. We show that the faradaic efficiencies for the reaction lie in a wide range of 18-82% for different carbon catalysts. In order to determine the cause of these differences, we employ prompt gamma ray/neutron activation analysis and XPS measurements to assess the contribution of heteroatoms and defects, as well as low temperature \( \text{N}_2 \)-adsorption and transmission electron microscopy to elucidate the particle size, shape, BET surface area and porosity. We find that the surface oxygen groups, nitrogen and sulphur content display effects that are not straightforward, because their chemical state is likely significant. The metal content (when present in the order of magnitude of \(~10\) ppm) is not a straightforward indicator of the electrocatalytic performance for this reaction. XPS and BET data indicate that carbons displaying high selectivities for the 2-electron process contain more aliphatic-like, "defect" structures on the surface.