Oxygen electroreduction on nanoporous carbons: Textural features vs nitrogen and boron catalytic centers

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The objective our research is to investigate the role of small pores in ORR. They are expected to play different role than those "traditional" heteroatom-containing catalytic centers. We are looking for a clear evidence that pores of carbons, especially ultramicropores, promote ORR via different mechanism than that on heteroatom-containing catalytic centers.

Porous carbons containing either B and N heteroatom (~ 10 at. % each) or B- and N-free were synthesized and used as ORR metal free catalysts. The number of electron transfer was close to 4 (3.94) regardless the presence or not of heteroatom-based catalytic centers, and the onset potential reached 0.827 V (on Pt/C 0.888 V). The carbons were extensively characterized from the viewpoints of their surface chemistry and porosity. The results indicated that a high volume of small pores where oxygen can be strongly adsorbed enhances the ORR efficiency, positively affecting the number of electron transfer and the value of the onset potential. On carbons with moderate volume of ultramicropores, N and B catalytic centers compensate the porosity effect enhancing the performance. These two mechanisms of ORR can coexist leading to very efficient process on metal free carbon-based porous catalysts.

We have shown that adding that mechanism can markedly improve the performance of carbon-based metal free catalysts. To the best of our knowledge, the nanoporous carbons tested here have one of the highest reported contents of N and B (combined) in their category of carbon allotropes, besides being porous and rich in structural defects.