

Waste to Electrocatalysts via Pyrolysis: Upcycling the Discarding Cigarette Butts into Oxygen Reduction Reaction Electrocatalysts

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Abstract

Adhering to the concept of circular economy, an innovative methodology was commenced to consume discarded cigarette butts as a cheap and readily available feedstock for the fabrication of meta-nitrogen-carbon (M-N-C) electrocatalysts via pyrolysis. Transformation of common carbonaceous waste that is still outside the common recycling pathways i.e. cigarette butts into novel Pt-free M-N-C type electrocatalysts for oxygen reduction reaction (ORR) in fuel cells not only solves environmental challenges but can also address the energy crises. The research design consisted of the following steps, all of which were thoroughly analyzed: (a) acquiring the carbon-rich char through the pyrolysis of the cigarette butts at 450 °C, 600 °C, 750 °C and 900 °C; (b) inducing porosity via chemical activation with potassium hydroxide and (c) functionalizing the activated carbon with iron (II) phthalocyanine (FePc) to develop M-N-C electrocatalysts. The ORR aptitudes of the developed electrocatalysts were examined under all three pH media and a descending inclination in the performance activities with respect to pyrolysis temperature was witnessed. The sample pyrolyzed at 450 °C i.e. cig_450 surpassed its counterparts in all three pH media by realizing the uppermost onset (E_{on}) and half-wave ($E_{1/2}$) potentials. The recorded E_{on} and $E_{1/2}$ for cig_450 came out to be 0.88 V and 0.5 V vs. reversible hydrogen potential (RHE) in acidic media, 0.77 V and 0.43 V vs. RHE in neutral media and 0.91 V and 0.85 V vs. RHE in alkaline media. In-depth structural analysis revealed that the extraordinary electrocatalytic activity of cig_450 is linked with the higher surface area, disordered graphitic architecture and abundance of Fe-N_x active moieties. Such attributes ensured optimum performance along with nearly tetra-electronic ORR [1].

References:

- [1] D. Testa *et al.*, “Giving New Life to Waste Cigarette Butts: Transformation into Platinum Group Metal-Free Electrocatalysts for Oxygen Reduction Reaction in Acid, Neutral and Alkaline Environment,” *Catalysts*, vol. 13, no. 3, Art. no. 3, Mar. 2023, doi: 10.3390/catal13030635.