

The 2012 Herbert H. Uhlig Summer Research Fellowship — Summary Report

Oxygen-Promoted Anodic Oxidation of Bisphenol A on Nickel Foam Electrodes

by Julia van Drunen

Bisphenol A (BPA) is an endocrine disrupting chemical that has the potential to harm humans and wildlife. Electrochemical oxidation was successfully applied as an environmentally sustainable method for degrading this compound.¹ Anode materials already applied to this process typically contain Pt or other high-cost materials (e.g., Pt, Ti/PbO₂, Pt/Ti, boron-doped diamond). Low cost Ni electrodes are attractive materials for oxidation of organic molecules because Ni displays catalytic properties similar to those of Pt; specifically it has the ability to dissociate water and break C-O and C-C bonds. This study examines open-cell Ni foam (Fig. 1) as an inexpensive, yet effective anode for the degradation of BPA. This material offers a high electrochemically active surface area (250 – 400 cm² g⁻¹)² and a large pore volume; it consists of one electrically conductive unit and can be cut to any shape or size.

We used chronoamperometry (CA) and cyclic voltammetry (CV) to study the anodic oxidation of BPA. The working electrode consisted of circular Ni foam pieces (12 mm in diameter) attached to a Ni wire. All studies were conducted in 0.5 M aq. KOH containing 0.005 M BPA. The oxidation took place in the presence of O₂(g) either generated *in situ* through the oxygen evolution reaction (OER) at $E > 1.6$ V vs. RHE or provided by bubbling O₂(g) through the cell.

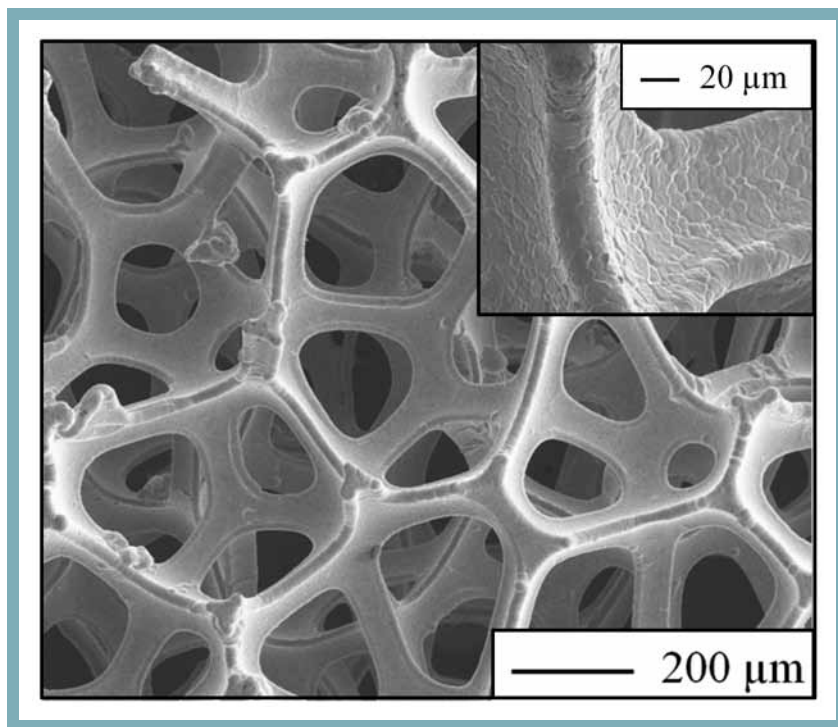


FIG. 1. Scanning electron microscope images of Ni foam.

The oxidation of BPA in this system occurs at ca. 1.3 V with a subsequent oxidation of reaction intermediates at 0.9 V (Fig. 2). The Ni foam surface must be in an oxidized state and some dissolved O₂(g)

must be present for the reaction to proceed. When O₂(g) is supplied to the system by bubbling, oxidation of BPA proceeds with a small, steady j . When oxygen is generated

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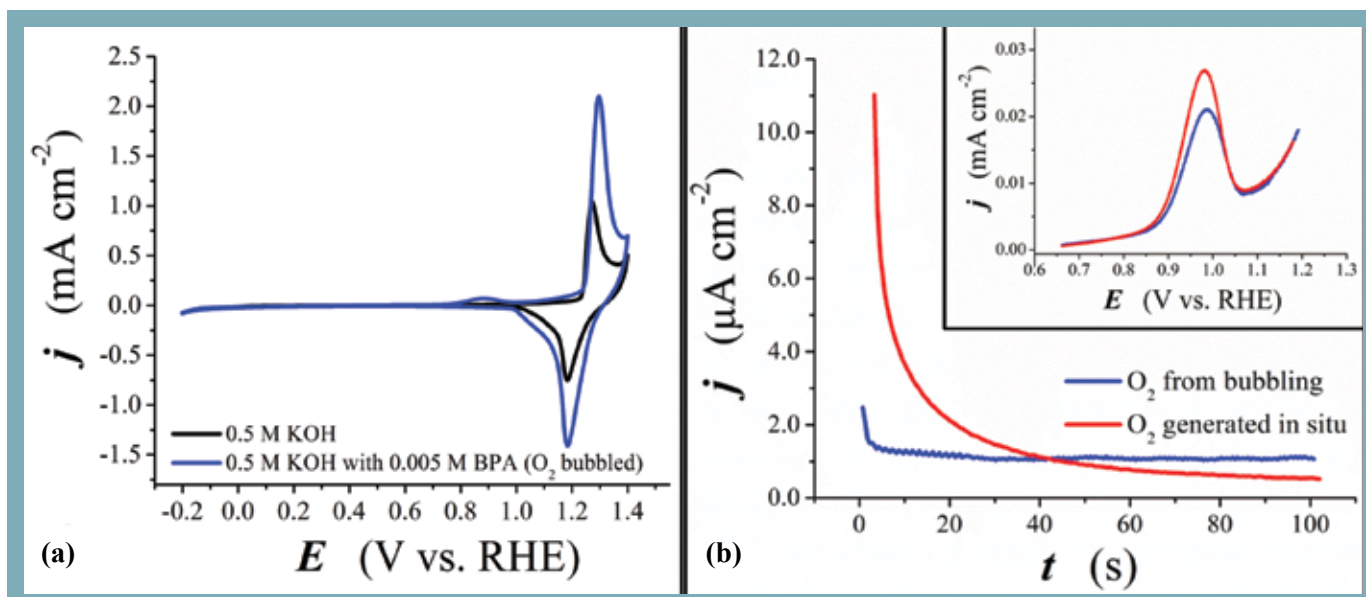


FIG. 2. (a) CV of Ni foam collected in alkaline electrolyte with (blue) and without (black) 0.005 M BPA ($s = 50$ mV s⁻¹); (b) CA at $E = 0.9$ V of Ni foam in 0.5 M KOH electrolyte with 0.005 M BPA. Inset: Excerpts from the anodic portion of CV of Ni foam in 0.5 M KOH electrolyte with 0.005 M BPA ($s = 50$ mV s⁻¹). All CV scans shown are from the 2nd cycle.

through OER, the initial j is higher; however, j quickly decreases to a small steady state value as $O_2(g)$ is consumed.

On the basis of these preliminary results, we propose a suitable method for the oxidation of BPA using a Ni foam anode and the application two different E values in a pulsed sequence. The approach consists of a square E wave which switches between 1.8 V and 0.9 V. Such a sequence (i) provides high enough E for the initial oxidation of BPA and (ii) generates $O_2(g)$ *in situ* to promote the reaction. The application of 0.9 V as part of the method facilitates the degradation of intermediates throughout the process.

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