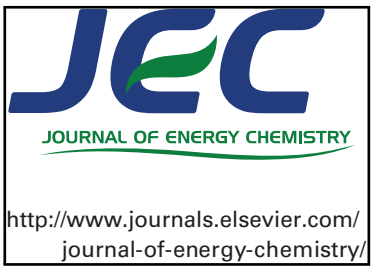

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The influence of electrochemical treatment on electrode reactions for vanadium redox-flow batteries

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Abstract

Through targeted and reproducible electrochemical treatment of glassy carbon electrodes, investigations have been carried out on the electrochemical behaviour of the oxidation of V^{2+}, VO^{2+} and the reductions of VO_2^+, VO^{2+} and V^{3+} in order to pretreat electrodes specifically for use in vanadium redox flow batteries and, if possible, to treat them in situ. For this purpose, a glassy carbon electrode was treated potentiostatically for a period of 30 s at different potentials in the range of 500 mV–2000 mV vs. Hg/Hg_2SO_4 in 2 M H_2SO_4 and then linear sweep voltammograms were performed in the different vanadium-containing solutions. With this method, it could be shown that all reactions are extremely surface sensitive and the reaction speeds changed by several decades. The reaction rates increased significantly in all reactions compared to polished electrodes and had an optimum treatment potential of approx. 1600 mV vs. Hg/Hg_2SO_4, although the oxidation reaction of V^{2+} and the reduction reactions of V^{3+} and VO^{2+} had opposite tendencies to oxidation of VO^{2+} and the reduction of VO_2^+ in the area of low treatment potentials. In the former, the kinetics increased and in the latter, they decreased. In addition, causes were investigated using confocal microscopy and XPS. No correlation was found to the roughness or size of the stretched surfaces, although these changed significantly as a result of the treatment. XPS measurements gave indications of a dependence on hydroxyl groups for the oxidation of VO^{2+} and the reduction of VO_2^+, while for the reactions of oxygen-free cations and the reduction of VO^{2+} weak indications of a dependence on carboxyl groups were obtained.

1. Introduction

As a possibility for inexpensive storage of renewable energy and due to its unique character, the separate scalability of energy and power, as well as the possibility of using relatively inexpensive active materials, redox flow batteries (RFB) [1-2] are nowadays the subject of commercialization and