Abstract #1004, 223rd ECS Meeting, © 2013 The Electrochemical Society

Tungsten Electrodes with Rough Surfaces and their Electrochemical Reactivity

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The understanding of chemical reactions for actinides in high temperature molten salt is essential to develop and verify the non-proliferating pyro-chemical process. The electrochemical method has been effectively used to study the actinide-related reactions in molten salt. One of the key issues of the electrochemical analysis from the environmental viewpoint is to obtain reliable data with the lowest possible amount of the radioactive species.

Reducing the size of the electrochemical cell might be the easiest solution for this. However, it requires new design of reference electrode suitable to small cell and more importantly it diminishes the electrochemical sensitivity to the radioactive species due to the undersized working electrode surface and the accompanying reduced electrochemical active area. Another option for lowering the amount of radioactive species in the test cell is to raise the surface reaction rate of the working electrode. This approach is relatively much feasible and promising as compared to the miniaturized cell because the test cell doesn't have to be modified.

Most effective way to enhance the areal surface reactivity (*i.e.*, current density) is to make the electrode surface porous. The difficulty is the fact that the control of the surface roughness of the metals used in molten salt (*e.g.*, molybdenum and tungsten) is basically not so easy. In particular, despite that the chemical etchant of tungsten is widely known, the effect of etching condition on surface irregularity has not been properly studied. Furthermore, there are no works, as far as we know, on the electrochemical behavior of the chemically roughened tungsten electrodes with different surface irregularities.

In this work, tungsten electrodes with different surface roughnesses were prepared and their surface morphology and apparent electrochemical reactivity were quantitatively analyzed, in order to investigate the feasibility of the roughened tungsten samples as a highly-reactive working electrode. For this purpose, tungsten electrodes were chemically etched in hydrogen peroxide solution to have various surface irregularities and the self-similar fractal dimensions of their surfaces were determined on the grounds of the scaling property. Then, the total charges passed during cathodic hydrogen evolution on their surfaces were estimated in the potentiostatic condition.

In this presentation, the etching conditions critically affecting the morphology of tungsten surface will be suggested. Moreover, the utility of fractal dimension will be discussed as a measure of the electrochemical reactivity of rough tungsten electrodes.

References

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