pH response behaviors and mechanisms of different tungsten/tungsten oxide electrodes for long-term monitoring

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Abstract: Tungsten/tungsten oxide electrodes were prepared by four kinds of methods and their pH response behaviors in lithium borate buffer solutions at 25 ^{o}C have been investigated by electrochemical measurements. It was found that tungsten/tungsten oxide electrode made by immersion in HNO_3 solution was unsuited to the testing environment because it tended to exfoliate or dissolve during tests. All the other tungsten/tungsten oxide electrodes showed linear response to pH values and good stability during the long-term potential monitoring. The lower dissolution rate of tungsten/tungsten oxide electrode made by heat-treatment made it the best candidate for the long-term monitoring due to its compact oxide film formed on the surface. X-ray photoelectron spectroscopy and thermodynamic analysis have been done to evaluate pH response mechanisms of the corresponding electrodes.

Keywords: tungsten/tungsten oxide electrode, tungsten electrode, pH measurement, corrosion monitoring

1. Introduction

The monitoring of pH is widely used for evaluating and controlling service environments as well as corrosion processes in industry. So far, glass electrode is commonly used for such purpose in various fields except for some harsh conditions, such as high temperature aqueous environments in power plants [1]. pH measurement at elevated temperatures needs specialized pH electrodes, like hydrogen electrode [2-4] and yttria stabilized zirconia (YSZ) membrane electrode [5-7]. Hydrogen electrode has a strict requirement for measuring environment and it has been employed principally in laboratory studies. YSZ membrane electrode is used extensively for pH measurements in a wide variety of environments, especially in industrial systems. But it is not sensitive at a relatively low temperature (around 200 ^{o}C) due to the limited diffusion of oxygen