The Construction and Significance of Chromium Nitride Pourbaix Diagrams in Regards to Corrosion Products

"Pourbaix diagrams" can be described as a rough map as to what corrosion products may form given a known corrosion potential and acidity. These diagrams are generated for the metal compounds of chromium nitrides CrN and Cr_2N, given lack of literature. Chromium nitrides can be described as important for research due to its use as a surface layer material to increase the wear resistance and hardness of surfaces. Some differences may exist between experimental and theoretical results due to unaccounted factors such as surface defects and rate of reactions; however, general agreement with Pourbaix diagram predictions is still expected. As such, the design and manufacture of better performing materials involving chromium nitrides is hoped to be aided as appropriate usage cases against corrosion become more easily predicted.

Abstract

Chromium nitrides such as CrN and Cr_2N are often used for corrosion and wear resistant applications. These can be analysed using Pourbaix diagrams to help gauge the thermodynamic stability of elements and compounds that could form when exposing chromium nitrides towards corrosive environments. Within this research, Pourbaix diagrams were constructed for CrN and Cr_2N assuming thermodynamical data for species at 298 K (25°C), a concentration of 10^{-6} M for aqueous species, and a pressure of 1 bar. When compared to other Pourbaix diagrams in literature for chromium and chromium carbides, it was found that chromium nitrides had a larger region of immunity against corrosion. Small differences between products predicted from Pourbaix diagrams and actual products in situ are expected due to Pourbaix diagrams not fully being able to account for reaction kinetics and depositional defects. Generated Pourbaix diagrams also showed that it was possible for passive Cr_2O_3 chromium oxide films to form on the surface of chromium nitrides; however, despite Cr_2O_3 normally being protective, it is argued that its formation is more detrimental towards corrosion resistance due to degrading the otherwise stable chromium nitrides. As such, further experimental testing to validate the corrosion resistance of chromium oxides on chromium nitrides is desired in future. By creating Pourbaix diagrams for chromium nitrides such as CrN and Cr_2N, the design and manufacture of better performing materials may be aided as the appropriate usage cases become more easily predicted.