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Formation of Protective Aluminum-Oxide Layer on the Surface of Fe-Cr-Al Sintered-Metal-Fibers via Multi-Stage Thermal Oxidation

Authors : Loai Ben Naji, Osama M. Ibrahim, Khaled J. Al-Fadhalah

Abstract : The objective of this paper is to investigate the formation and adhesion of a protective aluminum-oxide (Al₂O₃, alumina) layer on the surface of Iron-Chromium-Aluminum Alloy (Fe-Cr-Al) sintered-metal-fibers. The oxide-scale layer was developed via multi-stage thermal oxidation at 930 ^oC for 1 hour, followed by 1 hour at 960 ^oC, and finally at 990 ^oC for 2 hours. Scanning Electron Microscope (SEM) images show that the multi-stage thermal oxidation resulted in the formation of predominantly Al₂O₃ platelets-like and whiskers. SEM images also reveal non-uniform oxide-scale growth on the surface of the fibers. Furthermore, peeling/spalling of the alumina protective layer occurred after minimum handling, which indicates weak adhesion forces between the protective layer and the base metal alloy. Energy Dispersive Spectroscopy (EDS) analysis of the heat-treated Fe-Cr-Al sintered-metal-fibers confirmed the high aluminum content on the surface of the protective layer, and the low aluminum content on the exposed base metal alloy surface. In conclusion, the failure of the oxide-scale protective layer exposes the base metal alloy to further oxidation, and the fragile non-uniform oxide-scale is not suitable as a support for catalysts.

Keywords : high-temperature oxidation, iron-chromium-aluminum alloy, alumina protective layer, sintered-metal-fibers
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