Chemical mechanical polishing as an alternative surface treatment technique for corrosion prevention of carbon steel in an acidic medium

Scientific Reports • Article • *Open Access* • 2025 • DOI: 10.1038/s41598-025-98210-w

Ahmed, Mohamed [a] ; Ali Al-Timimi, Buthainah [b, c] ; Al-Ali, Maha [d] ; Abdullah, Ghassan H. [d] ; Khalaf Atiyaha, Safa [e] ; +2 authors

[a] Mechanical Engineering Department, College of Engineering, Tikrit University, Tikrit, Iraq

Show all information

Abstract

Chemical mechanical polishing (CMP) has been a standard technique in semiconductor manufacturing for achieving smooth surfaces. CMP utilizes a synergistic interplay of chemical and mechanical interactions to achieve the desired removal rates, selectivity, and ultimately planarity with different substrate materials. In this study, the impact of CMP on the surface properties of steel used in the petroleum industry was examined, with a focus on its corrosion behavior posttreatment. Steel samples were subjected to CMP with and without an oxidizer in a silica-based slurry, and their surface characteristics were compared to those of samples polished mechanically. The addition of an oxidizer to the slurry resulted in increased material removal rates and the formation of an oxide layer on the surface; this phenomenon was not observed in CMP without an oxidizer. However, in mechanical polishing, the action of silicon carbide grains on the steel surface led to an increase in the removal rate but caused a decrease in its corrosion resistance. Compared with other treatments,