

Corrosion mechanism and corrosion inhibition modification of 2Cr13 stainless steel for surgical instruments in NaClO disinfectant

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Abstract 2Cr13 stainless steel is a kind of martensitic stainless steel that is commonly utilized in the fabrication of surgical instruments, including tweezers, scissors, and scalpels. Surgical instruments in service need to be immersed in hypochlorous acid solution for disinfection, which led to the corrosion of 2Cr13. The World Health Organization (WHO) issued the recommendation to increase the available chlorine concentration of disinfection from 500 mg/L to 2000 mg/L to ensure complete inactivation of COVID-19. However, the increase of the available chlorine concentration may exert a detrimental impact on surgical instruments, and further investigation is required to elucidate the corrosion of 2Cr13 in elevated NaClO concentration solution. Therefore, the purpose of this study was to investigate the corrosion mechanism of 2Cr13 in 500 mg/L and 2000 mg/L NaClO solutions, and to mitigate the corrosion by introducing corrosion inhibitors. The results indicated that the Cr-poor interface between $M_{23}C_6$ carbide and matrix of 2Cr13 was preferentially dissolved in NaClO solutions, ultimately leading to carbides detachment and the formation of pitting. It was revealed that the corrosion rate initially increased, then decreased, and subsequently increased again in both NaClO solutions, and the re-increase of the corrosion rate occurred earlier in 2000mg/L NaClO. Additionally, the corrosion rate of 2Cr13 in 2000 mg/L NaClO reached 0.149 mm/a, which was 2.8 times higher than that of 500 mg/L NaClO (0.053 mm/a). The electrochemical detection during the corrosion demonstrated the presence of “destruction-repair-redestruction” behavior of the passive film, which was the fundamental cause for the alteration in corrosion rate of samples. Without compromising the disinfection efficacy, the addition of corrosion inhibitors significantly reduced the number of pits, and the impedance radius increased by 1-2 orders of magnitude, indicating effective corrosion inhibition. The results have important technical and economic significance for controlling the corrosion of surgical instruments.

Keywords 2Cr13 stainless steel, Corrosion mechanism, NaClO solutions, Corrosion inhibitor