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Enhancing Crack Resistance in Pearlitic Armor Flexible Risers: Insights from Microstructural Analysis and Stress Modeling in CO2-Rich Marine Environments

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This investigation delves into the mechanisms of crack propagation in pearlitic armor flexible risers exposed to CO2-rich marine environments. Through an integrative approach combining Scanning Electron Microscopy (SEM), Electron Backscatter Diffraction (EBSD), and Finite Element Modeling (FEM), we explore the gradient of mechanical properties across the material's depth. Our findings reveal a strategic balance between surface strength and inner shear stress resistance, characterized by a transition from ?-fiber and (0 0 1) surface texture to a {1 1 0}?uvw? texture in the deeper layers. The study identifies Mode I (KI) fracture as the predominant failure mechanism, with tensile stress playing a critical role in crack resistance. Particularly, cracks were found to be most susceptible to growth at the midsection pit (z/a = 0), where pit size significantly affects the stress intensity. This research highlights the crucial role of material processing and microstructural orientation in enhancing the mechanical properties and crack resistance of materials designed for harsh marine applications. By manipulating the microstructural orientation and processing of the steel, our study outlines a pathway for optimizing material properties to improve resistance to stress corrosion cracking (SCC), offering valuable insights for the development of robust materials capable of withstanding the challenges of marine environments.