Chromium Oxide Film Deposition on the Inner Surface of Fine Tube by Multiple Porous Plasma Jet

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Metal pipe fittings are widely utilized across various industries, including oil transportation, marine engineering, aerospace, and defense, owing to their exceptional mechanical properties and durability. However, a prevalent issue during their operation is the occurrence of failures caused by severe corrosion on the internal surfaces of the fittings. Therefore, the development of effective anticorrosion coatings for the inner surface of pipelines holds paramount significance. Nonetheless, developing such coatings for small-diameter pipes remains a significant challenge due to spatial constraints. To address this challenge, this study proposes an innovative surface modification strategy employing rigid plasma brush technology. By employing a pulsed power-driven multiple porous plasma jet apparatus, controlled deposition of chromium oxide is achieved on the internal surface of the fittings. The spiral motion of the fittings ensures uniform coating deposition along the entire length of the pipeline. A comprehensive characterization approach is employed to analyze the deposited coating, encompassing surface morphology, cross-sectional morphology, film thickness, elemental composition, and chemical structure. Advanced techniques, including scanning electron microscopy, spectroscopy, and X-ray diffraction, are utilized for accurate and detailed characterization of the coating. Furthermore, extensive corrosion resistance testing is conducted to evaluate the coating's efficacy in enhancing corrosion resistance. Electrochemical testing and simulated seawater contact angle testing are employed to assess the coating's corrosion resistance performance. The research findings demonstrate a significant increase in contact angle and a corrosion resistance improvement of over 90% following the application of the chromium oxide coating. By overcoming the limitations associated with traditional high-temperature deposition processes, such as thermal damage to the pipeline and poor film uniformity, this study presents a practical and versatile method for modifying the inner surface of small-diameter pipes under mild conditions. This innovative approach not only enhances the corrosion resistance performance of metal pipe fittings but also extends their service life, thereby rendering them more reliable and economically efficient for diverse industrial applications.