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Electrochemical Investigation of the Effect of Process Parameters on the Corrosion Behavior of Aluminum-Cladded Pressure Vessel Steel using Friction Stir Diffusion Cladding Process

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Abstract: Surface cladding and coatings are commonly used to protect structures against corrosion in corrosive environments. In this paper, electrochemical properties of friction stir diffusion cladded ASTM A516-70 with corrosion-resistant Aluminum alloy grade 5052 are studied. The effect of process parameters, tool rotational and traverse speeds, on the corrosion behavior of produced cladded steels was comparatively assessed. Electrochemical analyses revealed that the cladded steel sample provided good corrosion protection performance in comparison with the un-cladded steel substrate following the immersion test up to 21 days in 3.5% NaCl medium. Increasing the tool traverse speed was found to negatively affect the corrosion resistance. Optimum parameters for the selected clad system were found to be 500 rpm tool rotational speed, and 50 mm/min tool traverse speed for protection against general corrosion. Meanwhile, higher traverse speed demonstrated stable passivation behavior and, therefore, lower propensity for pitting localized corrosion. Post characterization of the exposed area indicated that tool shoulder marks were favorable spots for the accumulation of corrosion products.

Keywords: friction stir welding; cladding; corrosion; pressure vessel steel; electrochemical impedance spectroscopy

Figure S1. Optical images of typical FSDC processed samples for FH-1 (A50), FM-1 (B50) and FL-1 (C50).

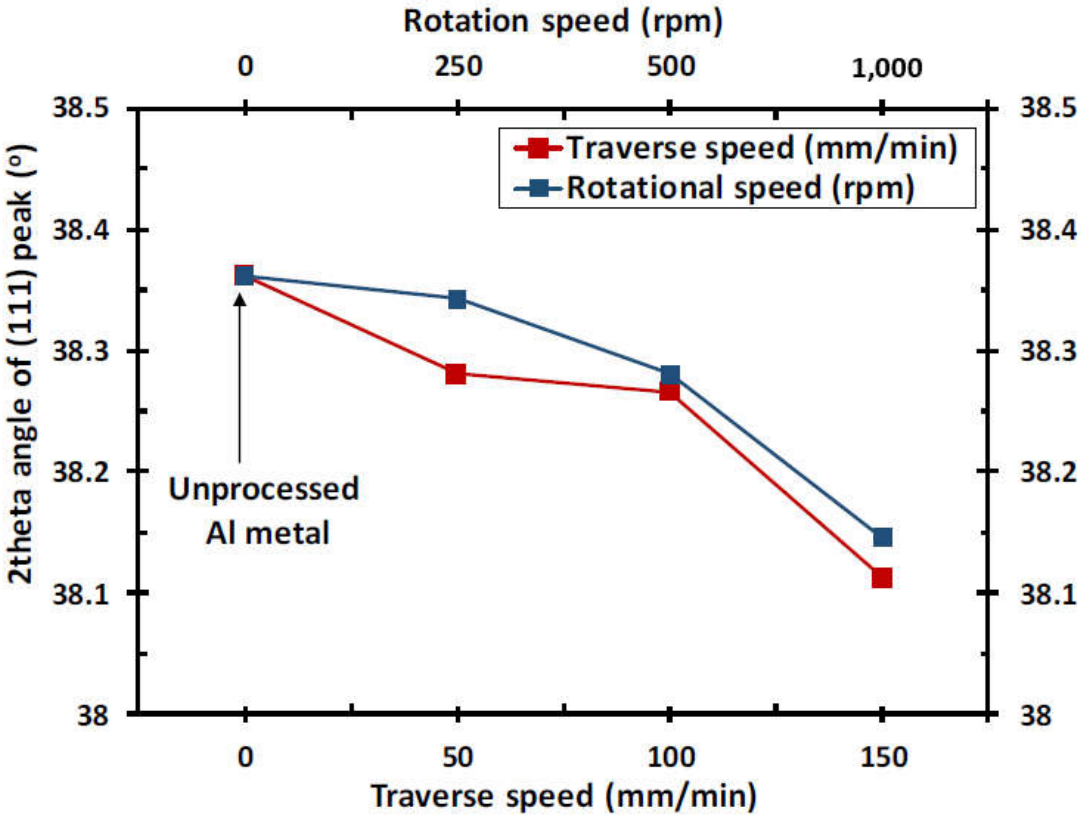

Figure S2. Diffraction angles of the (111) peak showing the shift to lower angles as a function of rotation and traverse speeds.

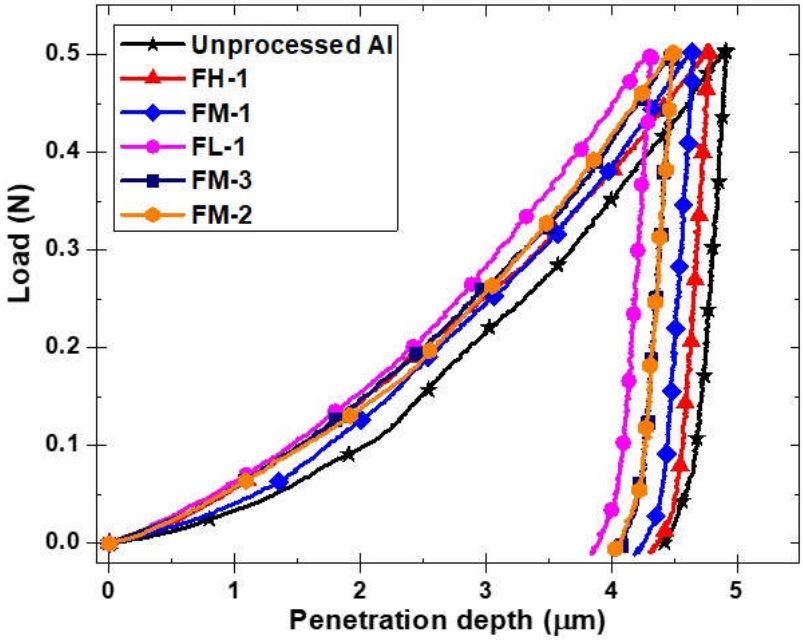

Figure S3. Load vs penetration depth curves for unprocessed Al and FSDC samples.

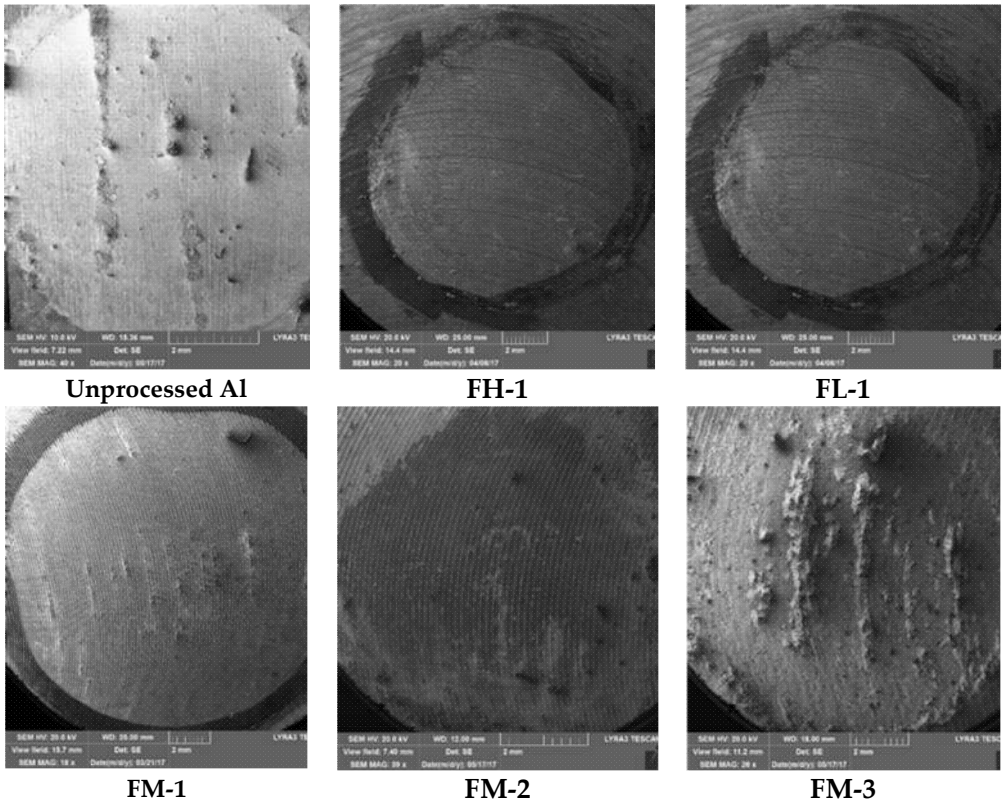

Figure S4. Low magnification SEM images of corroded surfaces.