Abstract

In situ electrochemical impedance spectroscopy measurements of organic coatings on mild steel under retort conditions

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Abstract: We present a novel experimental setup and method to evaluate changes in the corrosion protection performance of food can coatings applied to electrolytic tinplate *in situ* under retort conditions (121 °C for 90 min). Two polymer systems were compared: bisphenol A (BPA)-based epoxy and BPA non-intent (BPA-NI) polyester. The BPA-NI coatings were formulated with three levels of phenolic loading to control the properties of the polymer, specifically the glass transition temperature (T_g) as measured by differential scanning calorimetry. Coated metal coupons were exposed to 1% NaCl electrolyte solution and monitored before, during, and after retort sterilization using electrochemical impedance spectroscopy (EIS), where impedance data were collected over a frequency range from 100 kHz to 0.1 Hz and fitted to equivalent circuit models for analysis. Our results captured changes in model parameters (e.g., coating capacitance, pore resistance, and charge transfer resistance) during retorting. These data served as quantitative metrics for coating performance and were mapped to T_g to investigate mechanisms involved in coating changes during retort sterilization. During the retort sterilization cycle, pore resistance was observed to depend heavily on T_g, where a higher T_g (associated with a greater crosslink density) was observed to better retard the migration of corrosive species from the electrolyte to the metal substrate. These trends aligned well with those observed after 28 d of storage at 50 °C, suggesting potential service life prediction capability using the novel experimental setup. It follows that *in situ* EIS measurements under retort conditions could serve as a useful tool to screen coating formulations to streamline the design and development of BPA-NI coating platforms.