A new approach to elucidating the surface interaction of organic corrosion inhibitors

D. Chekulaev, M. Torres Molina, A.G. Thomas, R. Lindsay,
D. Collison, R.E.P. Winpenny
University of Manchester, Manchester, UK

Corrosion inhibitors reduce the corrosion rate of a metallic substrate by inducing a change at or near its surface, without significantly changing the concentration of corrosive species. This approach to corrosion control is well established, and has long been the focus of significant research activity. Nevertheless, corrosion inhibitor selection and development for technological application largely remains an empirical process, involving trial-and-error performance testing of candidates. Such an approach partially arises from the complex nature of the parameter space influencing inhibitor functionality, but is also a result of a lack of mechanistic knowledge. One outstanding issue is detailed knowledge of the interfaces formed by inhibitive organic species in acidic solutions, which are widely encountered in engineering applications, e.g. chemical processing and oil production. Here, we describe a new approach to gaining insight into this topic through the application of vibrational sum frequency spectroscopy (VSFS), in combination with reference data acquired from metal-cage complexes.

VSFS is a novel surface-specific optical technique, enabling identification of adsorbed species through their vibrational signatures. Most pertinently, it can be applied to solid/fluid interfaces, and thus is potentially a powerful tool to probe adsorbed inhibitors. However, vibrational spectra from such systems can be complex, and additional input is required to aid unique interpretation. Given this scenario, we acquire vibrational data from metal-cage complexes, comprising appropriate metal atoms (substrate) and ligands (corrosion inhibitor). The structure of these species can be determined from diffraction, and so vibrational resonances can be assigned much more reliably, facilitating improved identification of features in VSFS spectra. We will demonstrate the potential of this approach to elucidating the surface interaction of organic corrosion inhibitors through presenting data from carbon-steel inhibited by 2-mercaptobenzimidazole in hydrochloric acid solution.