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Design of novel electrochemical techniques for measuring some of the remarkable features of the passivation of metals, and its breakdown

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Abstract: Electrochemical methods are unique in their ability to elucidate, identify and quantify some highly complex features of passivation and corrosion of metals. This discussion introduces novel electrochemical methods designed to quantify some of these processes. Analysis of the remarkable state of passivity in stainless steel is described using the results of cyclic thermammetry, whereby the temperature of an electrochemically controlled system is cycled linearly. Under some circumstances, the passive current density can be so low, that it is difficult to measure. The discussion shows how extraordinarily sensitive these processes are to temperature. The breakdown of passivity of the metal, leading to catastrophic pitting corrosion can be described through extremely sensitive measurements of electrochemical noise, and the measurement of these processes is discussed. Much new information can be gleaned from this carefully controlled experiment. It is shown that the genesis of pitting corrosion is an event of nanometre dimension, and there are many of them: the conversion of a pit nucleus into a fully propagating pit is however, inefficient. Breakdown of passivity induced by mechanical impact, a common form of erosion corrosion, can also be examined by sensitive electrochemical measurements, and this methodology is described.

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