Novel assessment of atmospheric corrosion of brass under sodium chloride-containing water droplets using the scanning Kelvin probe

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Imitating gold at a fraction of the cost is an attribute of brass that has driven watchmakers and minters to utilise this alloy, providing their products with desirable aesthetics while being commercially feasible. Unfortunately, tarnishing under atmospheric conditions reveals the imitator all too soon. This study aims to simulate and measure a fundamental corrosion mechanism on brass.

As a NaCl water droplet becomes deficient in oxygen, a differential aeration cell is established whereby cathodic oxygen reduction becomes preferable at the droplet circumference. This region draws sodium cations to counteract the electronegativity associated with an accumulation of hydroxide anions producing a secondary spreading phenomenon – originating at the droplet perimeter and proceeding radially outside its boundaries.

A combination of time-lapse photography and height-regulated scanning kelvin probe (SKP) potentiometry is used to study cathodic secondary spreading phenomenon, following exposure to NaCl containing water droplets. The rates at which these highly alkaline electrolytic films proceed from the droplet edge are measured and are shown to follow parabolic kinetics. NaCl droplet concentrations ranging 0.1 – 5 mol/dm^3 exhibit significant rates of secondary spreading as shown using time-dependent E_{corr} vs distance plots, though visual analysis was inadequate in measuring similar rates at lower NaCl concentrations. Cl^- sequestering corrosion product under the droplet coupled with migration of Na^+ ions from the droplet bulk lower the solute concentration causing progressive evaporation under constant humidity, shown to be most extreme at lower NaCl droplet concentrations.