Removal of radionuclides into biogenic metal phosphate matrices: A novel remediation strategy

L.E. MACASKIE[1]*, C. MENNAN[1],
M. PATERSON-BEEDLE[1], J.A. READMAN[2]
AND J.A. HRILJAC[2]

[1]Unit of Functional Bionanomaterials, School of Biosciences, University of Birmingham, Edgbaston, Birmingham, B15 TT, UK (*correspondence: L.E. Macaskie@bham.ac.uk)
[2]School of Chemistry, University of Birmingham, Edgbaston, Birmingham, B15 2TT, UK

Bacteria can deposit crystalline metal phosphates via enzymatic hydrolysis of supplied phosphate esters. Uranium, plutonium, neptunium and americium can be immobilised in this way. Pu removal is expedited in the presence of a 'priming' deposit of another biogenic phosphate. This can comprise lanthanum phosphate ($LaPO_4$) or hydrogen uranyl phosphate (HUP: $HUO_2PO_4.4H_2O$) which facilitate Pu and Np removal. HUP is also an excellent ion exchange material for removal of ^{90}Sr, ^{137}Cs and ^{60}Co and the former can also be co-crystallised enzymatically along with with HUP. For treatment of contaminated natural waters HUP is undesirable due to its chemical and radiotoxicity. Zirconium phosphates (ZrP) have been documented to have a similar ion exchange function. Application of the enzymatic manufacturing method synthesised a biogenic ZrP material that had a capacity similar to chemically produced α-$Zr(HPO_4)_2$ for Sr^{2+} and 7-fold greater for Co^{2+}. The hydrolysable phosphate donor for 'proof of principle' was glycerol 2-phosphate but commercial use of this at large scale would be uneconomic. Phytic acid (inositol phosphate) is an attractive alternative since it is a plant storage material which is very widespread in soils and subsurface. Phytic acid contains 6 mol phosphate/mol, i.e. one phosphate group per carbon (as compared to 1:3 for glycerol 2-phosphate) and the waste carbon would pose less of an environmental burden. Bacterial phytases are widespread in nature. We will report on the potential for a ZrP-based remediation system made using bacterial phytase activity: a novel application for this enzyme.

Insights into the kinetics of acid corrosion reactions from direct analysis of surface morphology

EVA MACHNIKOVA[1]*, ROLF S. ARVIDSON[2],
CORNELIUS FISCHER[2], ANDREAS LUTTGE[1,2]
AND KENTON H. WHITMIRE[1]

[1]Department of Chemistry, Rice University, Houston TX 77005 (*correspondence: em2@rice.edu)
[2]Department of Earth Science, Rice University, Houston TX 77005

A quantitative understanding of corrosion reactions and their inhibition is critical in diverse problems involving the environmental impacts of waste disposal, catalysis, water treatment, and remediation of organic contaminants in groundwater. Conventionally, corrosion rate measurements have been accomplished by electrochemical techniques, e.g., double layer capacitance calculations from fitting of impedance spectra (Nyquist or Bode plots) to circuit models of the reactive interface (ac methods), calculation of corrosion current density from Tafel plots and linear polarization resistance (dc methods), as well as other (e.g. gravimetric change over time) methods. Integration of these methods permits straightforward comparisons of corrosion rate and evaluation of corrosion inhibitor efficiency [1]. However, in these various approaches the effects of surface heterogeneities that influence corrosion rate (i.e. surface defect density, impurities distributions, grain boundaries) are not directly analyzed and thus often incorporated as uncertainties within a given parameterization or the corrosion constant. In addition, calculation of corrosion rate from corrosion current may also involve problematic assumptions regarding sample surface area and the uniform distribution of corrosion rate. These assumptions may in turn result in underestimation of localized corrosion kinetics and their environmental significance.

In this unique study we combine information from electrochemical corrosion studies with direct measurement of acid corrosion rates using vertical scanning interferometry. This approach permits accurate resolution of surface kinetics and distribution of corrosion rates over significant areas of the metal surface. In addition, we adapt surface roughness parameters and convergence analysis [2] to characterize the intensity and distribution of corrosion reactions.

[1] Machnikova *et al.* (2008) *Electrochim. Acta* doi,10.1016/j.electacta.2008.03.021. [2] Fischer & Lüttge (2007) *Amer. J. Sci.* **307**, 955-973.