AFM measurement of adhesion forces under PWR conditions
identifies crud resistant coatings

M. Carlson¹, M. Short¹

¹Nuclear Science and Engineering, Massachusetts Institute of Technology, Boston, MA, USA

The build-up of corrosion deposits on fuel cladding in PWR cores, referred to as CRUD, forms a porous structure tens of microns thick which contributes to crud-induced localized corrosion (CILC), crud-induced power shift (CIPS), and activated material transport out of the core. Countering these effects can necessitate power deratings of 3-15% and million-dollar scale annual lost revenue. Due to the extreme conditions inside the reactor, an understanding of crud deposition at the individual-particle level has been limited to extrapolation from model systems at lower temperature and pressure. We present a custom, first of its kind, high temperature high pressure (315 °C, 14 MPa) High Pressure Atomic Force Microscope (HP-AFM) designed to carry out colloidal probe measurements of particle-surface adhesion force in PWR water. We test thin (100 nm) coatings and find candidate materials which decrease crud growth by up to an order of magnitude, with in-core test rod validation scheduled for 2020.