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

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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 ^{o}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.