PRECIPITATION IN NEUTRON IRRADIATED COPPER-FREE RPV STEELS

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The formation of Mn-Ni-Si phases that would produce large and unanticipated hardening and embrittlement in irradiated Cu-free reactor pressure vessel (RPV) steels was predicted more than a decade ago. Since large incubation doses were expected, these features were dubbed "late blooming phases" (LBP); however, LBP have proved to be an elusive quarry. Recent small angle neutron scattering, atom probe tomography and combined electrical resistivity Seebeck coefficient measurements have now provided unequivocal evidence of LBP in Cu-free alloys containing 1.6%Mn, 1.6%Ni, 0.25%Si and 0.005 to 0.040%P irradiated at 270°C at intermediate flux to ≈0.025 dpa. All techniques showed the Mn-Ni-Si features, with nominal volume fractions up to ≈0.6%, in the 0.005%P alloy; however, these features were not observed in the atom probe tomography examinations of the alloy with 0.040%P. Hardening ranged from ≈ 160 to 190MPa, consistent with the estimated volume fractions.

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