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Microstructure characterization of ion-irradiated nano-grained Ni-Mo-Cr alloy using diffraction line profile analysis

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Abstract:
Ni-Mo-Cr alloys were developed for molten-salt reactors and are expected to withstand the radiation damage above 10 dpa. It is well-known that that having a nano-grained microstructure could improve the radiation damage tolerance of structural alloys and thus extend operational lifetime of novel reactor systems. The defect evolution of the nano-grained Ni-Mo-Cr alloy was investigated under Au-ion irradiation with a dose of 15 and 30 dpa at room temperature. High-resolution X-ray diffraction patterns were collected at the 33BM beamline of the Advanced Photon Source (APS) and analysed using the Convolutional Multiple Whole Profile (CMWP) method with the option to interpret the diffuse scattering in the vicinity of Bragg reflections. Results show that both the average sub-grain size and twin boundaries spacing significantly increased, whereas the initial high dislocation density decreased after the irradiation. The interpretation of diffuse scattering indicates that most irradiation defects are small and vacancy in nature.