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Radiation Resistance of Willemite Samples Irradiated with Electron and Proton, Geant4 Simulations

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Enhanced thermal barrier coatings (TBCs) have the potential to facilitate the operation of next-generation gas turbines at increased combustion temperatures. Considerable research efforts are currently focused on the development of novel materials that surpass the performance of conventional industry standards. Beyond their use in turbines, TBCs are also being investigated for aerospace applications, particularly as protective layers capable of withstanding extreme thermal environments. This is especially critical for spacecraft, which are continuously exposed to cosmic radiation in the form of high-energy protons and electrons in the MeV range. Accordingly, it is essential to thoroughly evaluate the behavior of these coatings under irradiation conditions. In the present study, we examine the irradiation tolerance of silicate-based compounds synthesized via a hydrothermal microwave-assisted method. Specifically, we investigated the effects of proton irradiation on zinc silicates (willemite) and cerium-doped zinc silicates, exposing them to 15.5 MeV proton beams at fluencies ranging from 10^{13} to 10^{15} protons per square centimeter (p/cm^2). Building upon our previous findings, which demonstrated the superior resistance of Ce–Zn_2SiO_4 to electron irradiation relative to undoped zinc silicate, the current results indicate that these materials also exhibit notable resilience under proton irradiation. Moreover, the crystal structure of the materials remained stable post-irradiation, highlighting their potential suitability for high-radiation environments. Comprehensive computational modeling of these processes has been performed utilizing the GEANT4 simulation toolkit.

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