Modified Composite Thermoregulating Coatings Irradiated with High-Energy Particles

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SPACE STATIONS

GAS TURBINE ENGINES

Modified Composite Thermoregulating Coatings Irradiated with High-Energy electrons

The aim of this work is to investigate the radiation resistance of thermoregulating coating materials based on silicate compounds obtained by a new method (hydrothermal microwave) by using high-energy electron irradiation. Structural changes in the materials under the influence of radiation were studied using structural, morphological and spectral analysis.

Hydrothermal Microwave Synthesis

Microwave-assisted hydrothermal synthesis followed by high-temperature (1050°C) calcination was used to prepare pure and cerium-doped zinc orthosilicate (Zn_2SiO_4) pigments. The maximum temperature during the synthesis was measured to be ~240 °C, 2.45 GHz frequency.

Diffuse reflection

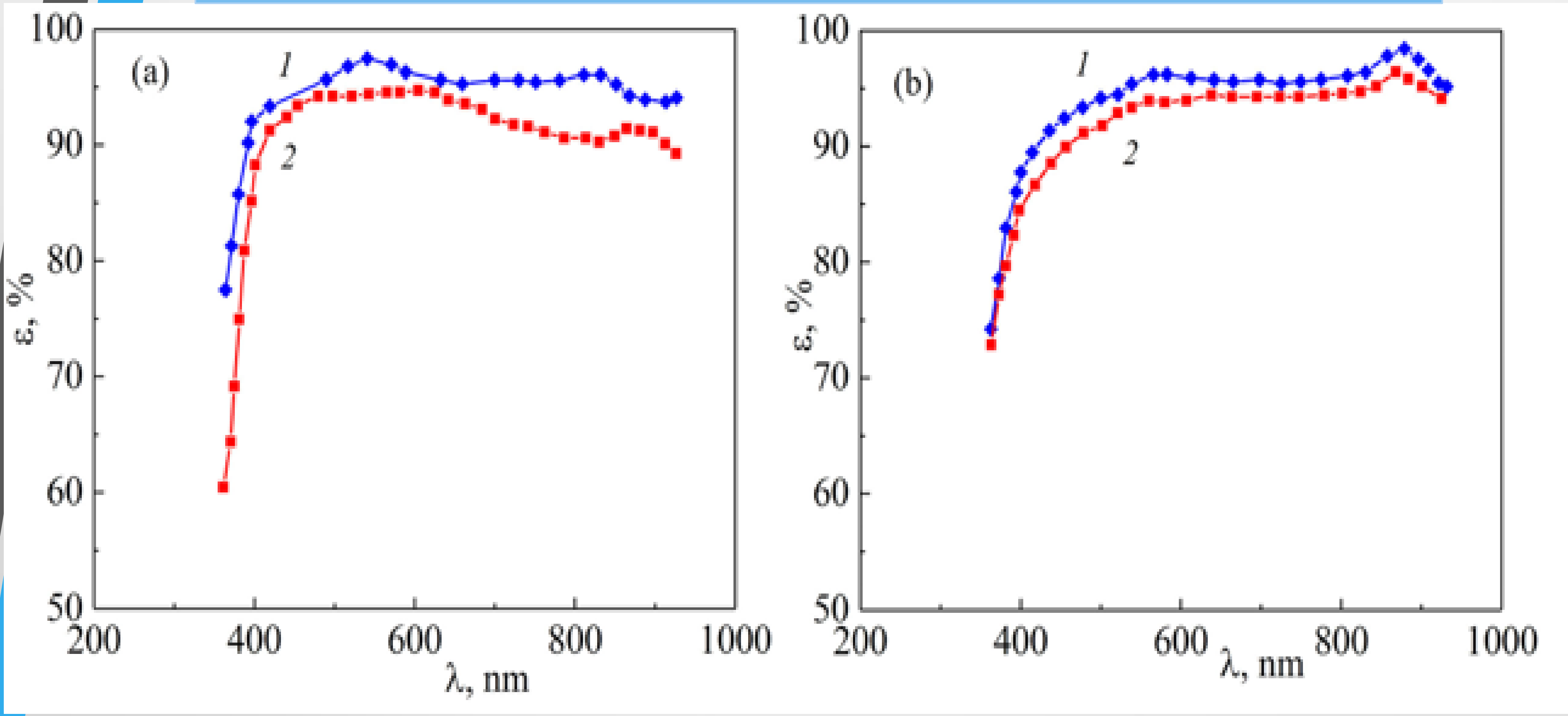

Fig. 1. Diffusion reflectance spectra of Zn_2SiO_4 (a) and Zn_2SiO_4 (Ce_2O_3-5%) samples (b) *1* – non-irradiated, *2* – electron irradiation with an energy of 20 MeV and a dose (10^{17} el/cm^2).

XRD patterns

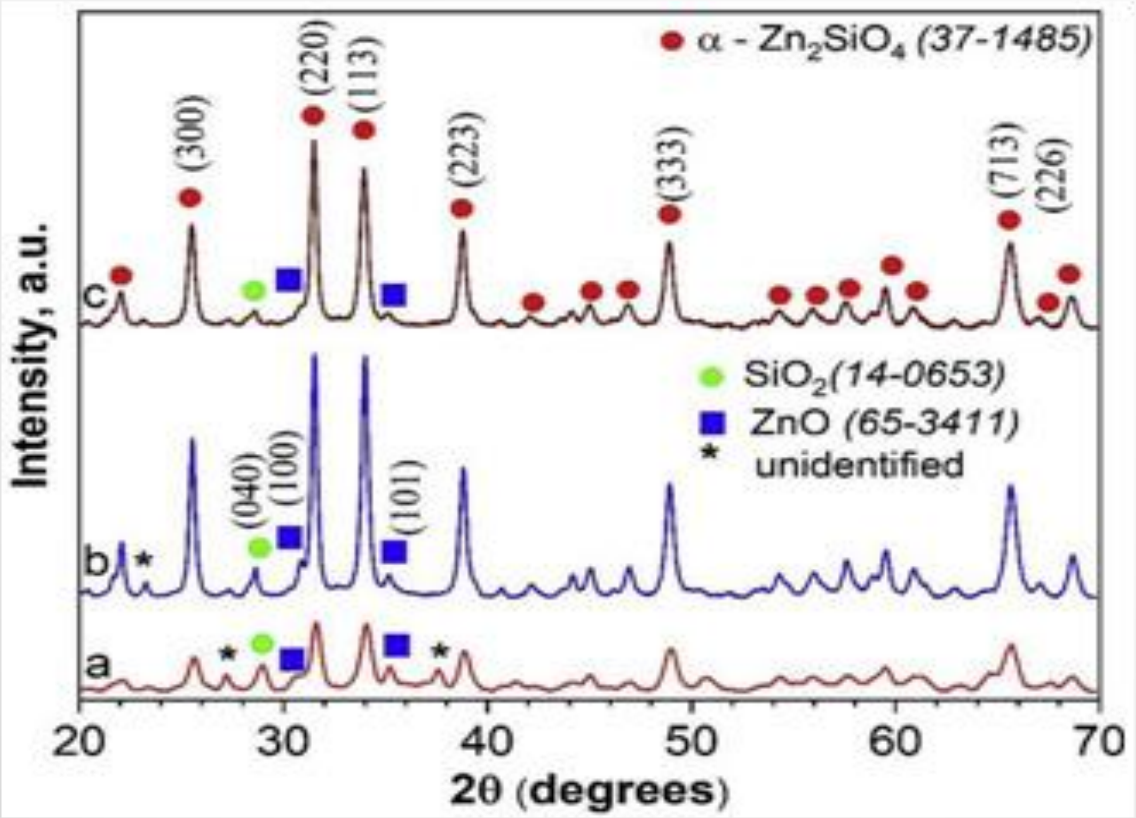

Fig. 2. XRD patterns of Zn_2SiO_4 (a, b) and Ce–Zn_2SiO_4 (c) synthesized under microwave irradiation at durations of 1.5 (a) and 3.5 h (b, c).

SEM images

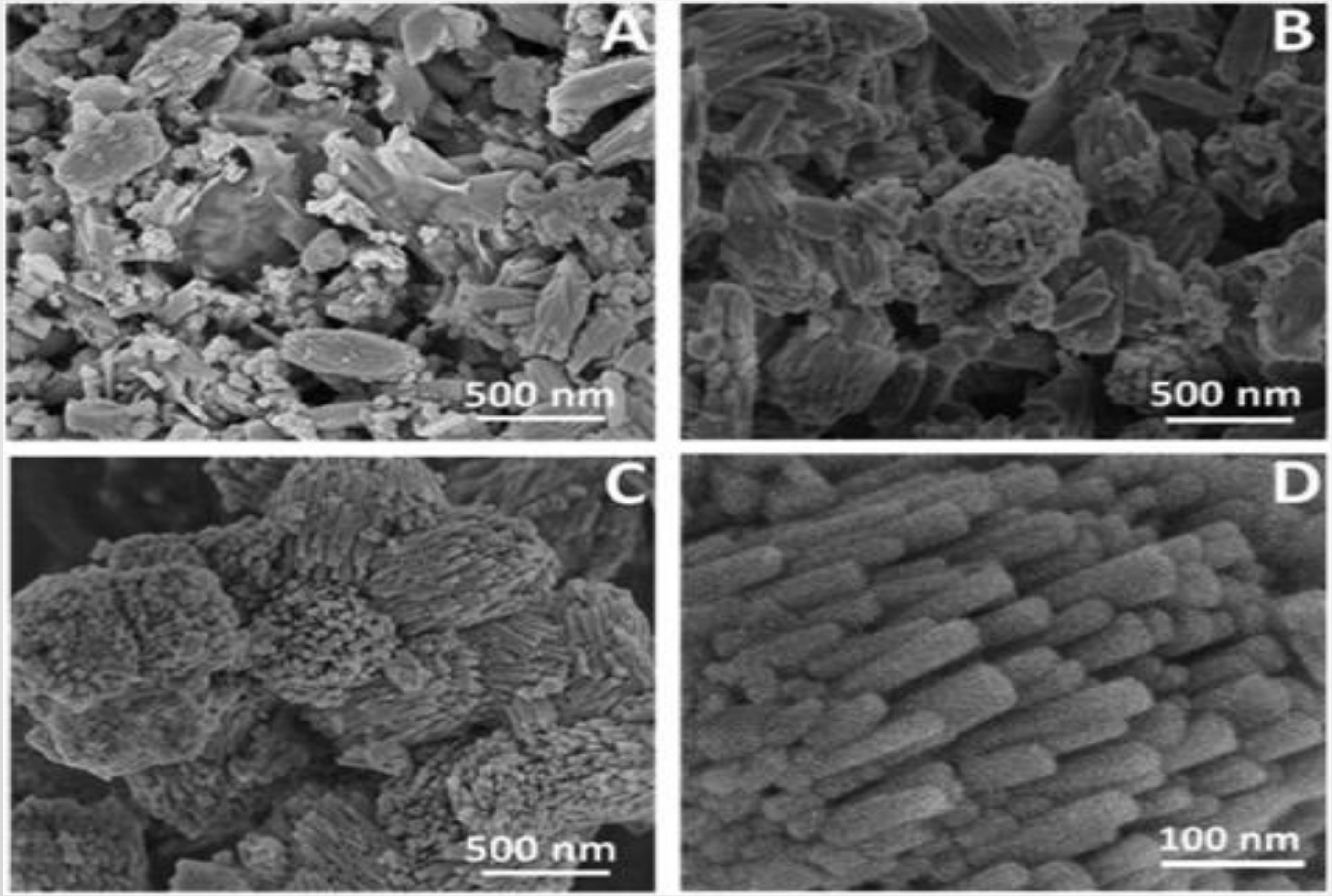

Fig. 3. SEM images of Zn_2SiO_4 (A, B) and Ce–Zn_2SiO_4 (C, D) synthesized under microwave irradiation for durations of 1.5 h (A) and 3.5 h (B–D).

XRD patterns

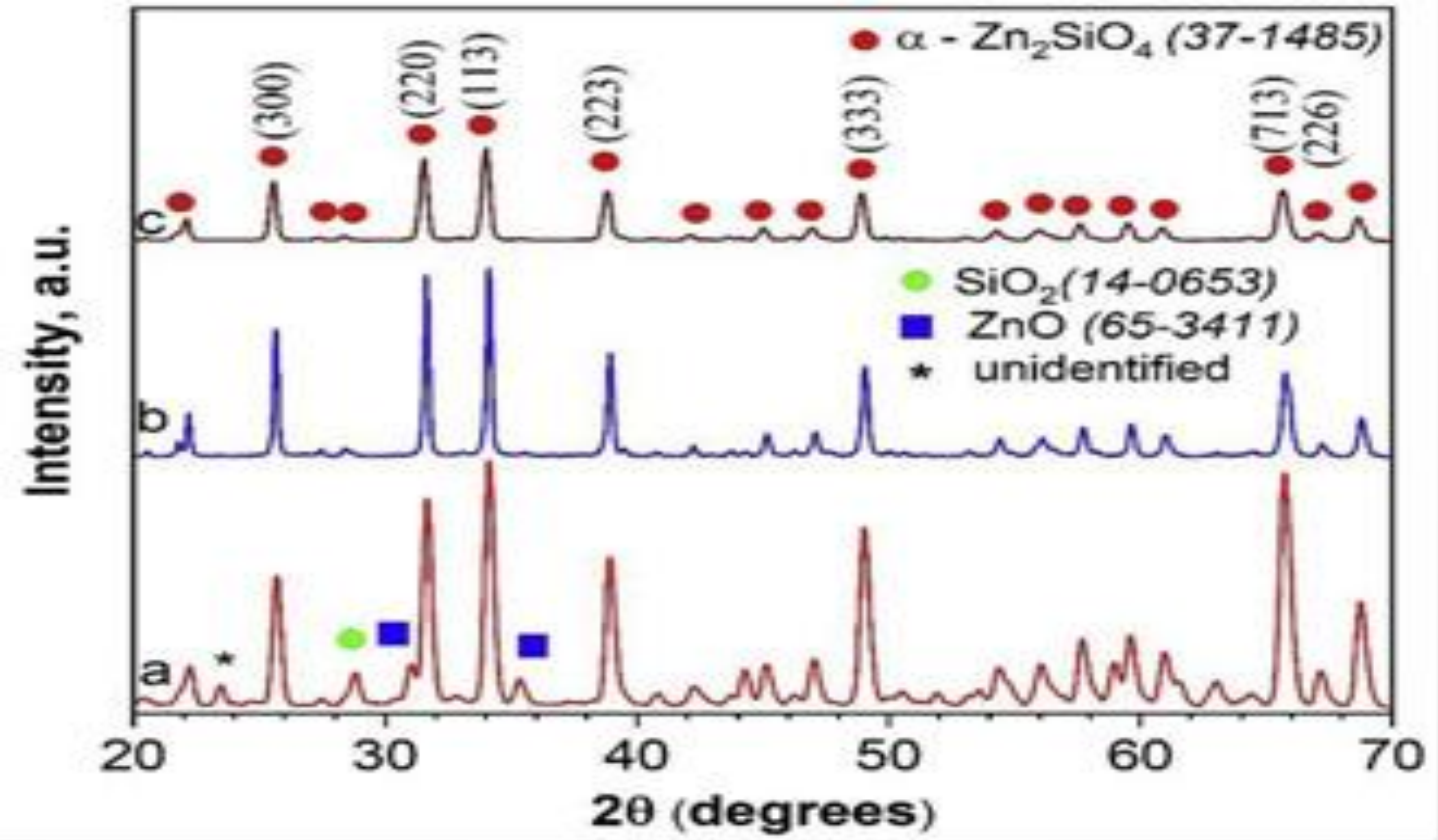

Fig. 4. XRD patterns of Zn_2SiO_4 (a) and Ce–Zn_2SiO_4 (b) samples calcined at 1050 °C as well as Ce–Zn_2SiO_4 subjected to 20 MeV electron irradiation with 10^{17} electron/cm^2 dose (c).

SEM images

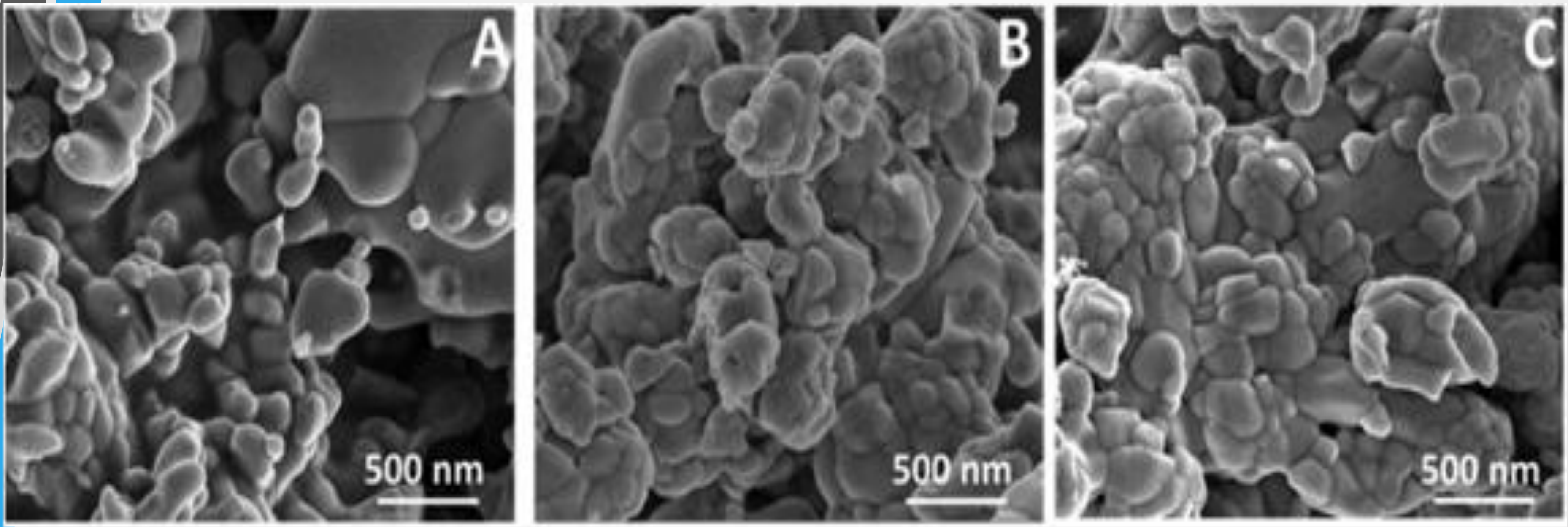

Fig. 5. SEM images of Zn_2SiO_4 (A) and Ce–Zn_2SiO_4 (B) samples calcined at 1050 °C as well as Ce–Zn_2SiO_4 subjected to 20 MeV electron irradiation with 10^{17} electrons/cm^{-2} dose (C).

TEM images

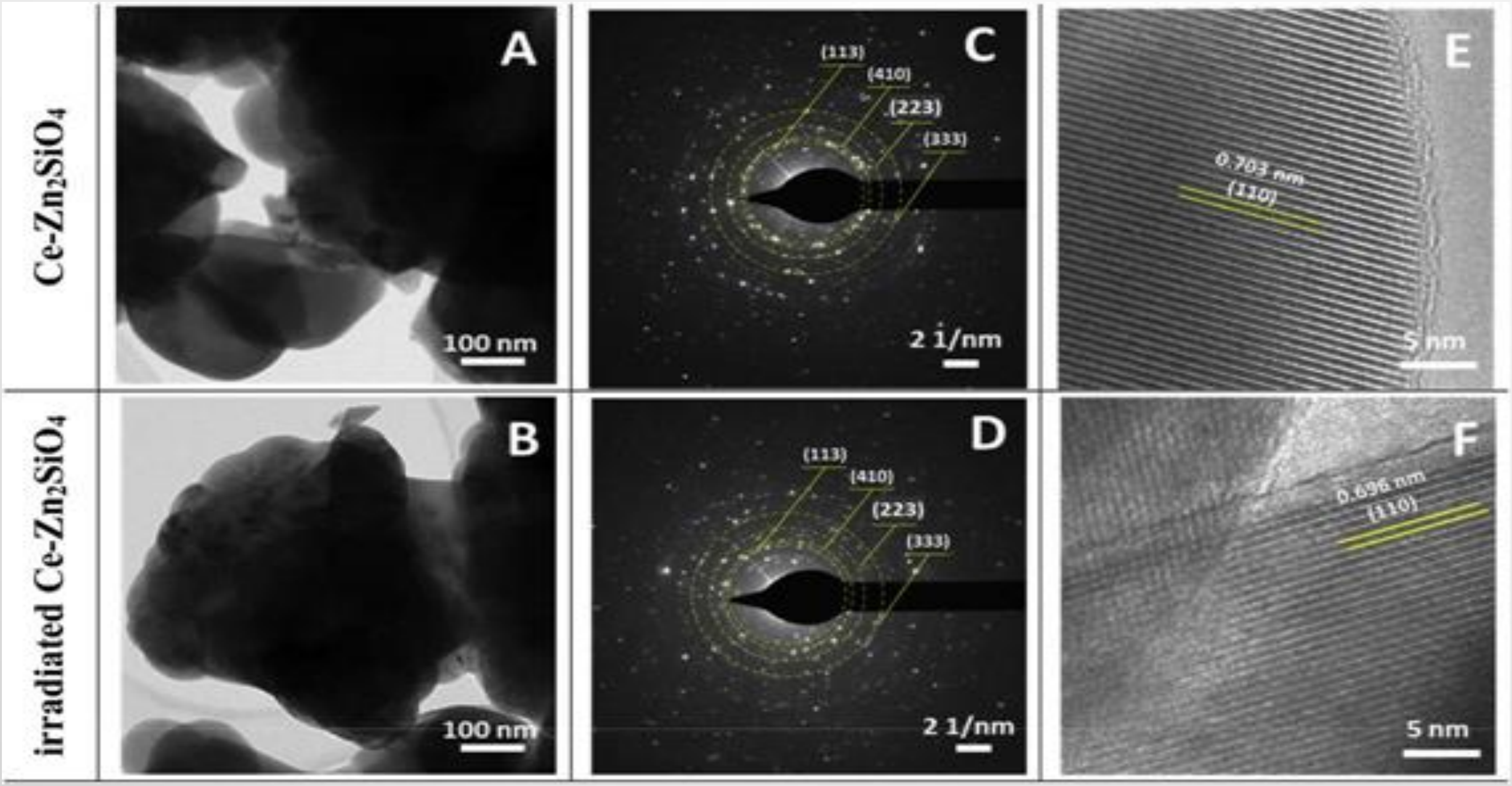

Fig. 6. Bright-field TEM images (A,B), selected area electron diffraction patterns (C,D) and high-resolution TEM images (E,F) of Ce–Zn_2SiO_4 before and after irradiation with 20 MeV electron beam and 10^{17} electrons/cm^2.

Conclusions

- Microwave-assisted hydrothermal synthesis methods allow the production of pure and Ce-doped Zn_2SiO_4. Ce-doping reduces the amount of unreacted ZnO and SiO_2 and increases their conversion to Zn_2SiO_4, as well as helps to obtain products with more uniform morphology.
- Measurements of the electron-irradiated materials indicate that Ce–Zn_2SiO_4 exhibits better radiation resistance compared to pure Zn_2SiO_4.
- The results show that thermoregulating coatings made of cerium-doped zinc silicate can be excellent candidates for use in spacecrafts and not only.

THANK YOU FOR YOUR ATTENTION