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A study on the photon interaction parameters of some meteorite samples

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Abstract

The goal of this work is to research photon interaction parameters of four meteorite samples which have various elemental contents from the scientific literature. Mass attenuation coefficients, effective atomic number values, effective electron density values, coherent scattering cross sections, incoherent scattering cross sections, photoelectric absorption cross sections, pair production cross sections for atomic nucleus and pair production cross sections for atomic electrons of present meteorite samples were obtained theoretically using computer software in energy range from 1 keV to 100 GeV. Consequently, photon interaction parameters of four meteorite samples vary depending on the incident photon energy and elemental components of the meteorite samples.

Introduction

- Photon interaction process depends on the photon energy.
- Photons interact with materrials mainlys as photoelectric effect, Compton scattering and pair production.
- At low photon energies, photoelectric effect is dominant whereas at higher 1022 keV photon energies, pair production is effective. At Mid photon energies, Compton scattering is dominant .
- Total attenuation coefficients are sum of the coefficients of the photoelectric effect, Compton scattering and pair production [1].

Material and Method

- In this study, Dhofar 19, Dhofar 461, Sikhote Alin and Chondrite L6 meteorites were investigated.
- Elemental contents of the components of the Dhofar 19, Dhofar 461, Sikhote Alin and Chondrite L6 meteorites were determined laser induced breakdown spectroscopy by De Giacomo et al. [2].
- Mass attenuation coefficients, effective atomic number values, effective electron density values, coherent scattering cross sections, incoherent scattering cross sections, photoelectric absorption cross sections, pair production cross sections for atomic nucleus and pair production cross sections for atomic electrons of present meteorite samples were obtained theoretically using WinXCom software [3] in energy range from 1 keV to 100 GeV.

Results

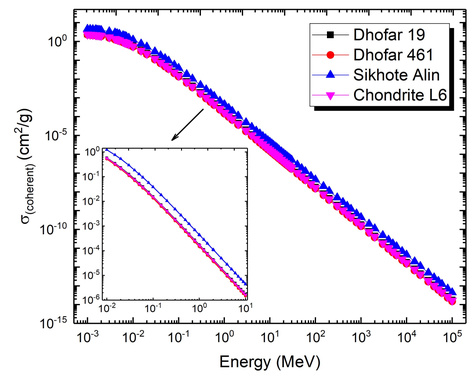

Fig. 1. Variation in coherent cross section ($\sigma_{coherent}$) as a function of photon energy for the meteorites

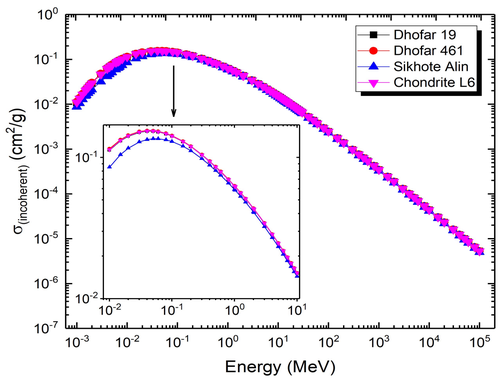

Fig. 2. Variation in incoherent cross section ($\sigma_{incoherent}$) as a function of photon energy for the meteorites

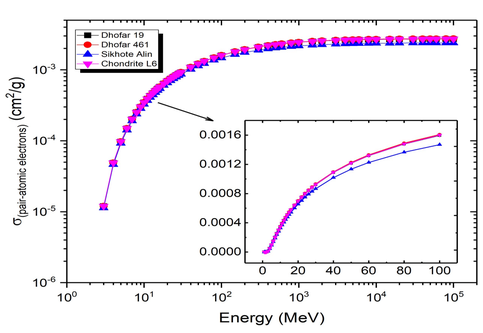

Fig. 3. Variation in pair-atomic electrons cross section ($\sigma_{pair\text{-}atomic\ electrons}$)as a function of photon energy for the meteorites

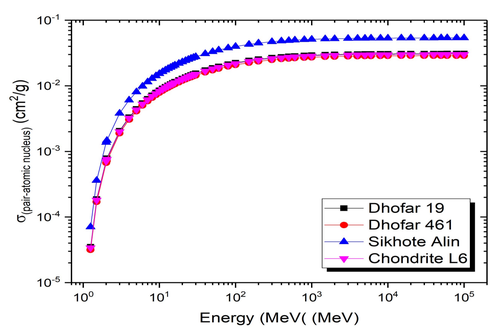

Fig. 4. Variation in pair-atomic nucleus cross section ($\sigma_{pair\text{-}atomic\ nucleus}$) as a function of photon energy for the meteorites

Results

Fig. 5. Variation in photoelectric effect cross section ($\sigma_{photoelectric\ effect}$) as a function of photon energy for

Fig. 6. Variation in mass attenuation coefficient (MAC) as a function of photon energy for the meteorites

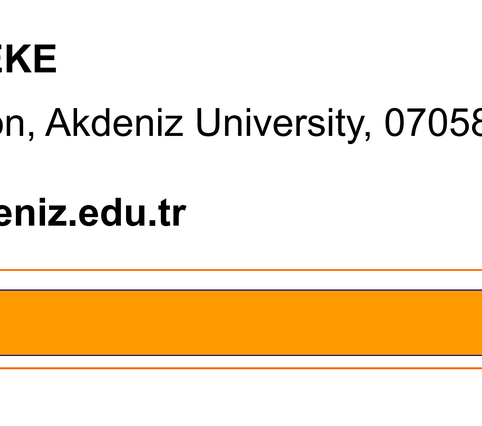

Fig. 7. Variation in total atomic cross section as a function of photon energy for the meteorites

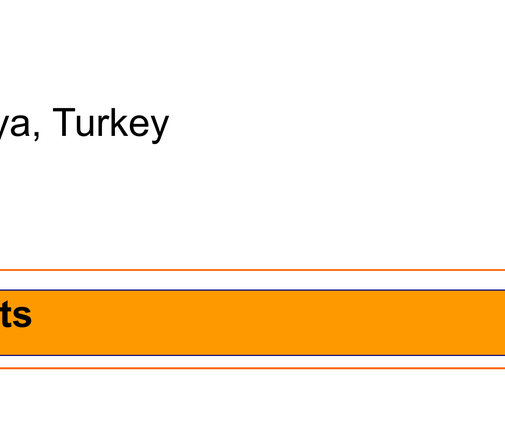

Fig. 8. Variation in total electronic cross section as a function of photon energy for the meteorites

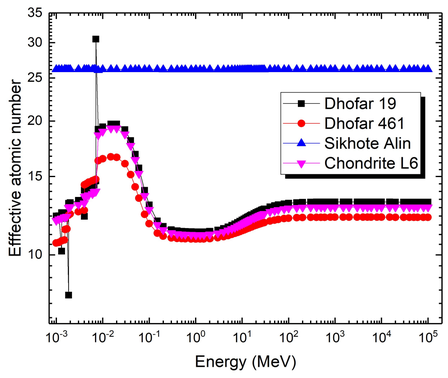

Fig. 9. Variation in effective atomic number (Z_{eff}) as a function of photon energy for the meteorites

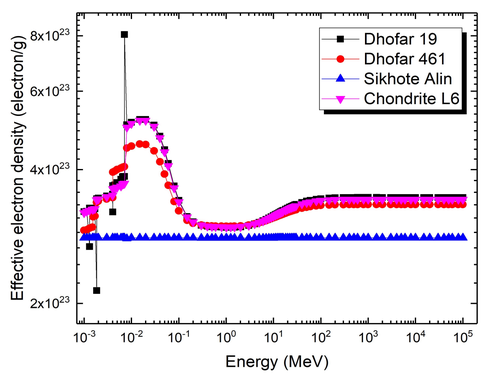

Fig. 10. Variation in effective electron density (N_{eff}) as a function of photon energy for the meteorites

Summary and Conclusion

- The $\sigma_{coherent}$ of meteorites decline with increment of photon energy. Sikhote Alin has the highest $\sigma_{coherent}$ values while Dhofar 461 has the lowest $\sigma_{coherent}$ values as indicated in Fig.1.
- The $\sigma_{incoherent}$ values of meteorites are maximum at 0.06 MeV and they are minimum at 10^5 MeV. Dhofar 461 has the highest $\sigma_{incoherent}$ values whereas Sikhote Alin has the smallest $\sigma_{incoherent}$ values as presented in Fig.2.
- The $\sigma_{pair\text{-}atomic\ electrons}$ and $\sigma_{pair\text{-}atomic\ nucleus}$ increase with increment of photon energy (see Fig.3 and Fig.4). The $\sigma_{pair\text{-}atomic\ electrons}$ values of Dhofar 461 are higher and the $\sigma_{pair\text{-}atomic\ electrons}$ values of Sikhote Alin are smaller than other present meteorites. The $\sigma_{pair\text{-}atomic\ nucleus}$ values of Sikhote Alin are higher and the $\sigma_{pair\text{-}atomic\ nucleus}$ values of Dhofar 461 are smaller than other present meteorites.
- The $\sigma_{photoelectric\ effect}$ values and MACs of meteorites decrease as photon energy enhances (see Fig. 5 and Fig. 6). Sikhote Alin has the highest $\sigma_{photoelectric\ effect}$ values and MACs in the present meteorites.
- The total atomic cross sections of meteorites change similar to total electronic cross sections of meteorites as displyed in Fig 8 and Fig.9.
- The Z_{eff} values vary similar to N_{eff} values. Z_{eff} and N_{eff} values of Sikhote Alin are stable as shown in Fig.9 and Fig.10.

References

[1] Gilmore GR (2008) Practical gamma-ray spectroscopy, 2nd edn. John Wiley & Sons Ltd., England.

[2] De Giacomo A, Dell'Aglio M, De Pascale O, Longo S, Capitelli (2007) Laser induced breakdown spectroscopy on meteorites. Spectrochimica Acta B 62, 1606-1611.

[3]Gerward L, Guilbert N, Jensen KB, Levring H (2004) WinXCom—a program for calculating X-ray attenuation coefficients. Radiation Physics and Chemistry 71, 653–654.