Energy Loss Function of Samarium

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Lanthanides are increasingly crucial in modern materials and technology, which have important applications in fluorescent lamps, luminescent probes, solar cells and laser science. Samarium and its compounds have been extensively studied and applied in recent years. However, understanding their excitation properties, particularly the plasmon structure, remains challenging due to their reactive chemical nature. The excitation properties are intricately linked to the energy loss function (ELF), which is associated with the frequency-dependent complex dielectric function, refractive index and extinction coefficient. Despite the importance of these functions for identifying various electronic excitations and facilitating new applications, limited data are available for the optical constants of samarium due to the limitations of conventional optical methods.

In order to obtain the ELF of samarium, a comprehensive study combining experimental and theoretical approaches was carried out within the energy loss range of 3-200 eV. The REELS measurement was carried out in the energy range of 0-200 eV at 2 keV primary energy. The samples underwent polishing and cleaning prior to measurement. Subsequently, they were introduced into the vacuum system and subjected to 48 hours of baking and Ar^+ ion bombardment until achieving a carbon-free surface. Ion bombardment was reiterated during measurement to ensure surface cleanliness. The absence of contamination on the material surface was confirmed by measuring the Auger peaks of Sm at 154 eV, C at 272 eV and O at 510 eV. At lower loss energies, clear identification of plasmon excitation is achieved, allowing for the distinction between surface and bulk contributions. To facilitate precise analysis, we employed the reverse Monte Carlo (RMC) method [1-3] to extract the frequency-dependent ELF from measured reflection electron energy loss spectroscopy (REELS) spectra. And the related optical constants (refractive index n and extinction coefficient k) were derived from the ELF

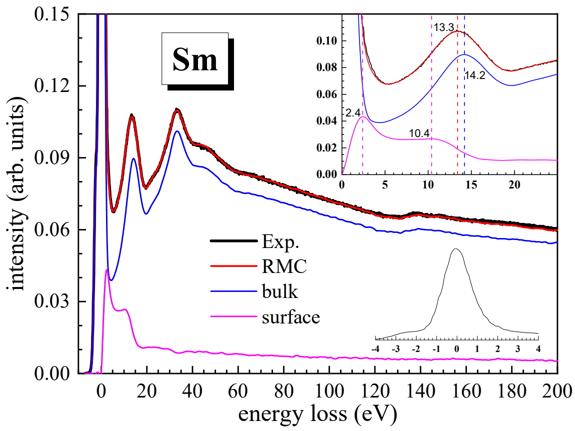

Figure 1. The measured and RMC-simulated REELS spectra of samarium.

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using the Kramers-Kronig relationship. The accuracy of the obtained ELF, imaginary part of the complex dielectric function ε_2, and the extinction coefficient k has been checked by *ps*-sum rule and *f*-sum rule, resulting in relative errors of 0.2% and 2.5%, respectively. Furthermore, our findings reveal a bulk mode located at 14.2 eV with a peak width of approximately 6 eV, and the corresponding surface plasmon mode broadening across energies of 5 to 11 eV, the excitation lines up to 200 eV are also determined and displayed.

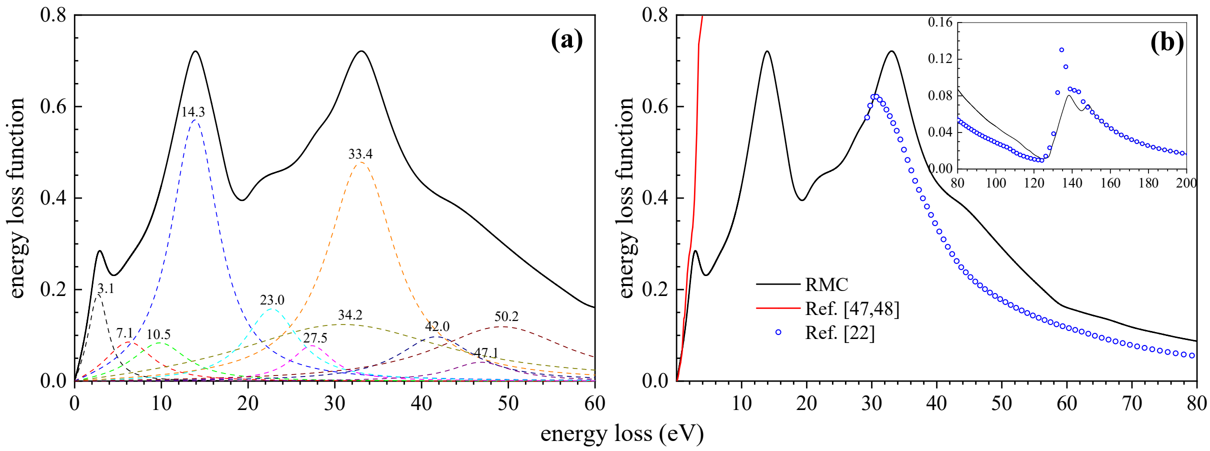

Figure 2. The derived ELF of samarium and comparison with literature data.

Keywords: lanthanides, samarium, reverse Monte Carlo method, dielectric function, energy loss function, optical constants, plasmon

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BIOGRAPHY

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