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Use of UV-Vis absorption spectroscopy in the characterization of cadmium chalcogenide colloidal quantum dots

Utilisation de la spectroscopie d'absorption dans l'UV-visible pour la caractérisation des points quantiques colloïdaux des chalcogénures de cadmium

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Foreword

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The committee responsible for this is document is ISO/TC 229, *Nanotechnologies*.

Introduction

Engineered nanoparticles of semiconductor materials with sizes down to the extent where the behaviour of electrons and holes are affected by the quantum confinement often possess unique electronic and optical properties intermediate between those of bulk semiconductors and those of discrete molecules. This normally refers to a nanoparticle diameter comparable to the Bohr radius of the exciton for the particular semiconductor material. Such nanoparticles are generally called quantum dots (QDs). A significant feature of these nanoparticles resulting from quantum confinement of charge carriers is size dependence of their electronic structure and, consequently, the excitonic absorption and emission wavelengths. Particularly, the transition energy from the valence band to the conduction band, and consequently the onset of absorption and the first excitonic transition (referred to here as first absorption peak position), is a function of the diameter of the particle (see Reference [1]).

Quantum dots commonly present sophisticated core-shell structures with a ligand shell controlling solubility and subsequent chemical functionalization. They are typically synthesized by chemical methods, with large-scale production and their size, shape, composition, and structure control capabilities. Commercially available quantum dots are mainly made from cadmium chalcogenide (CdTe, CdSe, CdS) materials. The size dependence of emission maximum, narrow emission band width, and good photostability make these engineered nanoparticles appealing in biological labelling and opto-electronics applications (see Reference [2]).

Ultraviolet-visible (UV-Vis) absorption spectroscopy has become a routine method to characterize QDs in a colloidal dispersion, by utilizing the relationship between the wavelength of the first excitonic absorption peak and the particle size that has been established after extensive photophysics research in the past, and using analytical methods for high-quality cadmium chalcogenide (CdTe, CdSe, CdS) materials of narrow size distribution. Key properties, such as average nanoparticle size and number concentration, can be approximately calculated from the measured absorption spectra. This Technical Specification intends to facilitate the use of UV-Vis spectroscopy for the characterization of quantum dot colloidal dispersions.