TECHNICAL SPECIFICATION

ISO/TS 11888

Second edition
2017-07

Nanotechnologies — Characterization of multiwall carbon nanotubes — Mesoscopic shape factors

Nanotechnologies — Caractérisation des nanotubes en carbone multicouches — Facteurs de forme mésoscopique

Reference number
ISO/TS 11888:2017(E)

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Foreword

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This document was prepared by Technical Committee ISO/TC 229, *Nanotechnologies*.

This second edition cancels and replaces the first edition (ISO/TS 11888:2011), which has been technically revised.

Introduction

Multiwall carbon nanotubes (MWCNTs) synthesized by chemical vapour deposition (CVD) are of growing interest for use in polymer composites and conductive coatings. In many cases, MWCNTs synthesized by CVD have static (permanent) bend points randomly distributed along their axis. Physical and chemical properties of mass-produced MWCNTs are strongly dependent on the statistical distribution of mesoscopic shapes and sizes of the individual MWCNT (see ISO/TS 80004-3), among other parameters, that comprise the product.[4][6] It is therefore crucial to characterize the mesoscopic shapes of MWCNTs in order to ensure that the final properties are reproducible for use in a wide range of materials, including composites and other dispersions, as well as for Environment, Health and Safety (EHS) issues.[7]

This document provides methods for the characterization of mesoscopic shape factors of MWCNTs, including sample preparation procedures. In particular, it provides a statistical method for characterizing MWCNTs produced by the CVD method. During MWCNT synthesis, axial structures are not perfectly linear but include static bend points.

This document provides methods for determining a statistical quantity, representing a maximum straight length that is not deformed by permanent bending called the “static bending persistence length” (SBPL). The SBPL gives information regarding the relationship between the MWCNT mesoscopic shape and size. If two MWCNTs of equal length have different SBPLs, their overall sizes (e.g. radius of gyration or an equivalent diameter such as a hydrodynamic diameter) will also be different from one another. In practical applications, the variation in SBPL affects both chemical reactivity and physical properties.[4][5][6]

Electrical conductivity and dimensional stability of MWCNT-polymer compounds are also strongly dependent on the SBPL of the MWCNT used to make them.[4][5][6] Various properties might be affected by SBPL, including electrical percolation threshold,[6][8] toxicity,[7] thermal conductivity,[9] rheological property[10] and field emission property.[11] SBPL could be useful for estimating the loading of a MWCNT-polymer matrix to achieve electrical conductivity (percolation limit) and should also assist with modelling the mechanical properties of MWCNT-polymer composites with different loadings.

Prior to commencing any work, users are advised to familiarize themselves with the latest guidance on handling and disposal of MWCNTs, particularly in relation to the use of appropriate personal protective equipment. Information on current practices is available in ISO/TR 12885.