Carbon materials

Applied analytical chemistry for the characterization of critical QC parameters

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Metrohm

A comprehensive portfolio

Due to properties such as, e.g., mechanical strength, high electrical and thermal conductivity, optical transparency, and more, carbon materials have become the subject of research for many applications.

We are one of leading manufacturers of instrumentation to study carbon materials. Numerous parameters can be determined with our portfolio of methods and instruments ranging from traditional wet chemistry to electrochemistry and to the latest, non-destructive spectroscopic methods. We can support you in your research on the following carbon materials:

Material	Parameter
Graphene	Structural properties (crystal defects, domain and flake size, number of layers, stacking angle)
	Water content
	Water soluble anions
	Oxygen content (Boehm titration)
	Electrochemical evaluation of graphene and graphene oxide (e.g., capacitance)
	Characterization in dependence of applied potential
	Sulfur, fluorine, chlorine, and bromine
Carbon nanotubes (SWCNT and MWCNT)	Disorder of crystal structure, dimensions of nanotubes
	Characterizationas a function of applied potential
	Water content (of suspensions)
	Oxygen content (Boehm titration)
	pH value of suspensions
Graphite	Characterization
	Characterization in dependence of applied potential
	Intercalation and de-intercalation of lithium
	Water content
	Sulfur
Carbon black (amorphous carbon)	Characterization
	Electrochemical characterization
	Iodine adsorption number (IAN)
	Water content
	pH value of suspension
Hard carbon	Insertion and de-insertion of sodium ion
	Water content

- Graphene, and related materials, such as graphene oxide (GO), and reduced graphene oxide (rGO) used, e.g., for flexible touch panels, organic light emitting diodes (OLED), solar cells, supercapacitors, and electromagnetic shielding.
- Carbon nanotubes (CNTs) used, e.g., as composite reinforcement material, in super capacitors, molecular sensors andhydrogen containers.
- Graphite used, e.g., as anode material in lithium ion batteries.
- Carbon black used as pigment in rubber and automobile tires and, more recently, as conducting pigment for printing applications.
- Hard carbon used in lithium and sodium ion batteries

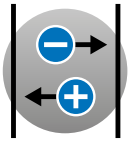
The following table gives you an overview of frequently analyzed parameters in carbon materials, the methods applied, and the respective standards describing them. Feel free to get more detailed information from the corresponding and linked Metrohm application documents. Missing your application? Contact your local Metrohm organization to discuss possible solutions.

Standard	Analysis technique	Application document
ISO/TR 19733, ASTM E3220	Raman spectroscopy	410000023-A
	Karl Fischer titration	
	Ion chromatography	
ISO/TR 19733, GB/T 38114	Titration	
	Electrochemistry	
	Raman spectroelectrochemistry	AN-RA-002
	Ion chromatography	
ISO/TR 10929 (MWCNT)	Raman spectroscopy	410000023-A
	Raman spectroelectrochemistry	AN-RA-002, AN-RA-005
ISO/TS 19808	Karl Fischer titration	
	Titration	
ISO/TS 19808	pH measurement	
	Raman spectroscopy	410000023-A
	Raman spectroelectrochemistry	AN-RA-002
	Electrochemistry	
	Karl Fischer titration	AB-434
ASTM C816	Titration	
	Raman spectroscopy	410000023-A, 410000002-B
	Electrochemistry	
ASTM D1510	Titration	AN-T-176
	Karl Fischer titration	AB-434
ASTM D1512	pH measurement	
	Electrochemistry	
	Karl Fischer titration	

Analysis techniques

RAMAN SPECTROSCOPY

Raman spectroscopy is ideally suited for the non-destructive characterization of carbon materials, with distinct bands attributable to the composition, structure, and other important properties. Disorder and dimensions of carbon nanomaterials can be characterized by Raman spectroscopy. Furthermore, by combining Raman spectroscopy with electrochemical measurements, the changes of the carbon material structure as a function of various potentials can be investigated.



ELECTROCHEMISTRY – IDEAL FOR STUDYING THE ELECTROCHEMICAL PERFORMANCE OF CARBON MATERIALS

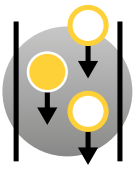
Our specially designed potentiostats/galvanostats are used for the electrochemical characterization of carbon materials. Electrochemical measurements are based on a highly accurate control and measurements of voltage, current, electrical charge, or impedance. They can even be combined with Raman spectroscopy to study the spectroelectrical characteristics of carbon materials.

TITRATION – SPECIFIC, ACCURATE, AND RELIABLE

Potentiometric titration is ideally suited for determining the oxygen content (Boehm titration) or the iodine adsorption number (IAN). It is an inexpensive method to determine functional groups on carbon materials. Furthermore, it can be automated to optimize efficiency in the laboratory.

KARL FISCHER TITRATION – THE PREFERRED METHOD FOR WATER DETERMINATION

Water can interfere in certain applications, e.g., lithium-ion batteries. Sensitive coulometric Karl Fischer titration is the ideal determination method for water content at trace levels in, e.g., nonaqueous carbon nanomaterial suspensions. For direct analysis of solids, the Karl Fischer oven method can be applied, where residual moisture in the sample is evaporated and transferred to the titration cell where it is titrated.



ION CHROMATOGRAPHY – HIGHLY EFFICIENT MULTI-PARAMETER ANALYSIS

Ion chromatography (IC) is an efficient and precise multi-parameter method to quantify anions and cations after extraction from carbon materials.