The carbon battle characterization of screen-printed carbon electrodes with SPELEC RAMAN

Carbon materials are a remarkable choice as electrode surfaces. They are not only cost-effective and chemically inert, but also have a low background current and a wide potential window. Physical and chemical properties of new carbon nanomaterials depend mainly on their structure, so their characterization is essential to choose the right material for different applications.

Raman spectroscopy is a very attractive technique for this purpose, effortlessly distinguishing information about the bond structure of carbon materials, and, therefore, about their possible properties. DropSens screen-printed electrodes (SPEs) are low-cost, disposable devices, available with working electrodes fabricated in several carbon materials. This Application Note describes how their properties can be studied by Raman spectroscopy.

INTRODUCTION

Carbon materials have a fantastic behavior as electrode surfaces because they are cost-effective, chemically inert, have a low background current and a wide potential window. Although the carbon era seemed to come to an end, the development of new carbon nanomaterials has provided novel applications for carbon in the 21st century. Physical and chemical properties of these materials depend mainly on their structure, so their characterization is essential to choose the right material for the appropriate applications.

Raman spectroscopy is a very attractive technique for material characterization and allows to know in an effortless way some information about the structure of carbon materials in terms of the sp^2 and sp^3 bonds, and, therefore, about their possible properties. In general, the G band of the Raman spectra (around 1580 cm^{-1}) could provide information on the fraction of sp^2 bonds and the D band (around 1300 cm^{-1}) could provide information on the fraction of sp^3 bonds (and some disorder in the structure). In some cases, a G' band also appears around 2600 cm^{-1} that could provide some knowledge on the layered structure of some of these materials.

DropSens screen-printed electrodes (SPEs) are low-cost, disposable devices, which are available with working electrodes fabricated in several carbon materials. Their properties can be studied by Raman spectroscopy as described in this Application Note.

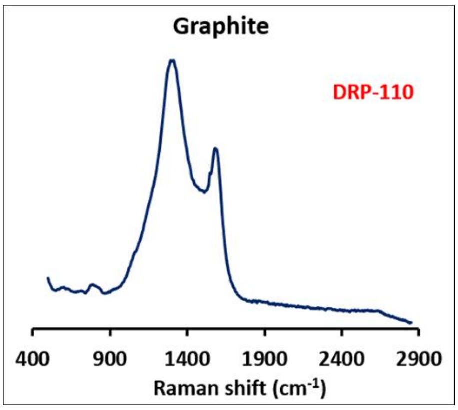
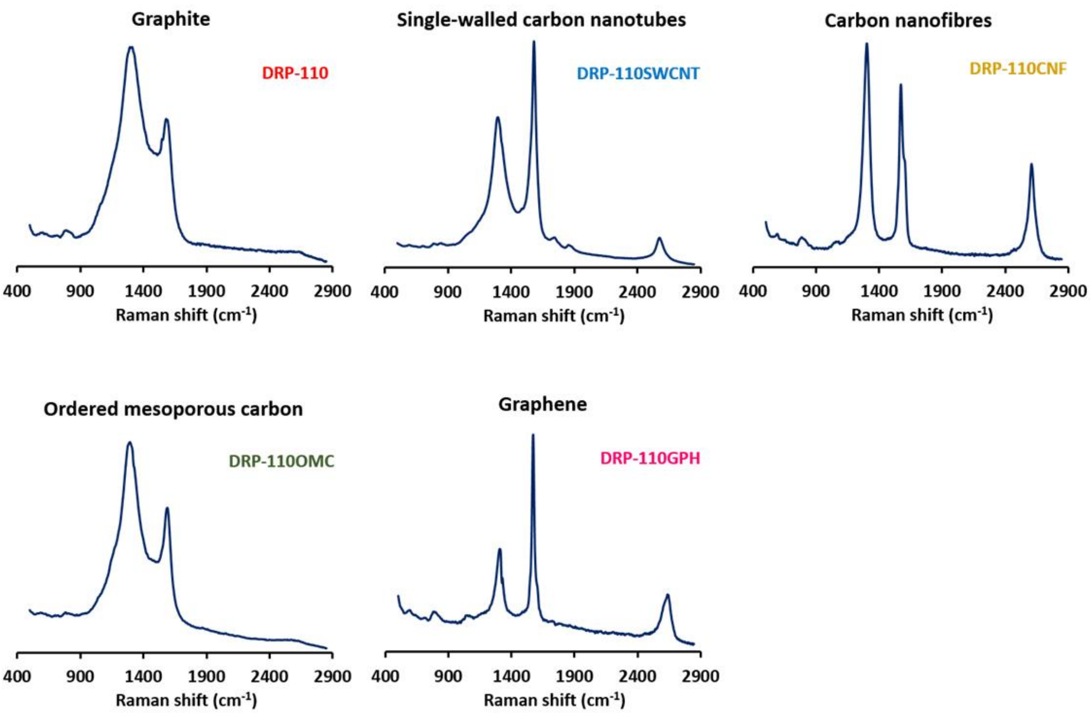


Figure 1. Raman spectrum of graphite

EQUIPMENT

The fabulous, compact and integrated instrument for Raman Spectroelectrochemistry, SPELEC-RAMAN, was used for this Application Note. This instrument integrates in only one box: a spectrometer, a laser source (785 nm) and a bipotentiostat/galvanostat. Screen-printed electrodes (refs. DRP-110, DRP-110SWCNT, DRP-110CNT, DRP-110OMC, DRP-110GPH, DRP-110CNF) were placed in a specific cell for this type of devices (DRP-RAMANCELL) coupled with the DRP-RAMANPROBE, which allows to perform the Raman measurements of the electrode surface at optimal focal distance. Integration time was 20 s.

Figure 2. The SPELEC-RAMAN used for the measurements in the application note.



CONTACT

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CONFIGURATION

Spectroelectrochemical Raman instrument (785 nm laser)

SPELECRAMAN is an instrument for performing spectroelectrochemical Raman measurements. It combines in only one box a laser class 3B (785 nm ± 0.5), a bipotentiostat/galvanostat and a spectrometer (wavelength range 787 – 1027 nm and Raman shift 35 - 3000 cm^{-1}) and includes a dedicated spectroelectrochemical software that allows optical and electrochemical experiments synchronization.

Raman Probe

Reflection probe designed to be used with a single excitation 785 nm wavelength (up to 500 mW). Suitable to work with DropSens Raman Cell for Screen-Printed Electrodes or with any conventional Raman set-up.

Raman Cell for Screen-Printed Electrodes

Black teflon reflection cell for performing Raman Spectroelectrochemistry with screen-printed electrodes in combination with ref. RAMANPROBE.

Screen-Printed Carbon Electrode

Screen-Printed Carbon Electrode (Aux.:C; Ref.:Ag). Suitable for working with microvolumes, for decentralized assays or to develop specific sensors.

Single-Walled Carbon Nanotubes modified Screen-Printed Carbon Electrode

Single-Walled Carbon Nanotubes modified Screen-Printed Carbon Electrode designed for the development of (bio) sensors with an enhanced electrochemical active area.

Multi-Walled Carbon Nanotubes modified Screen-Printed Carbon Electrode

Multi-Walled Carbon Nanotubes modified Screen-Printed Carbon Electrode designed for the development of (bio) sensors with an enhanced electrochemical active area.

Ordered Mesoporous Carbon modified Screen-Printed Carbon Electrode

Ordered Mesoporous Carbon modified Screen-Printed Carbon Electrode designed for the development of (bio) sensors with an enhanced electrochemical active area.

Graphene modified Screen-Printed Carbon Electrode

Graphene modified Screen-Printed Carbon Electrode designed for the development of (bio) sensors with an enhanced electrochemical active area.

Carbon Nanofibres modified Screen-Printed Carbon Electrode

Carbon Nanofibres modified Screen-Printed Carbon Electrode designed for the development of (bio) sensors with an enhanced electrochemical active area.