Application Note AN-RA-002

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.

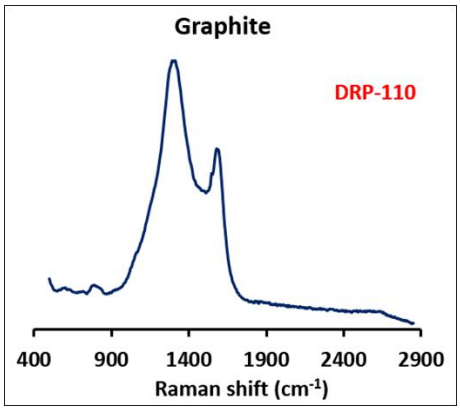


Figure 1. Raman spectrum of graphite

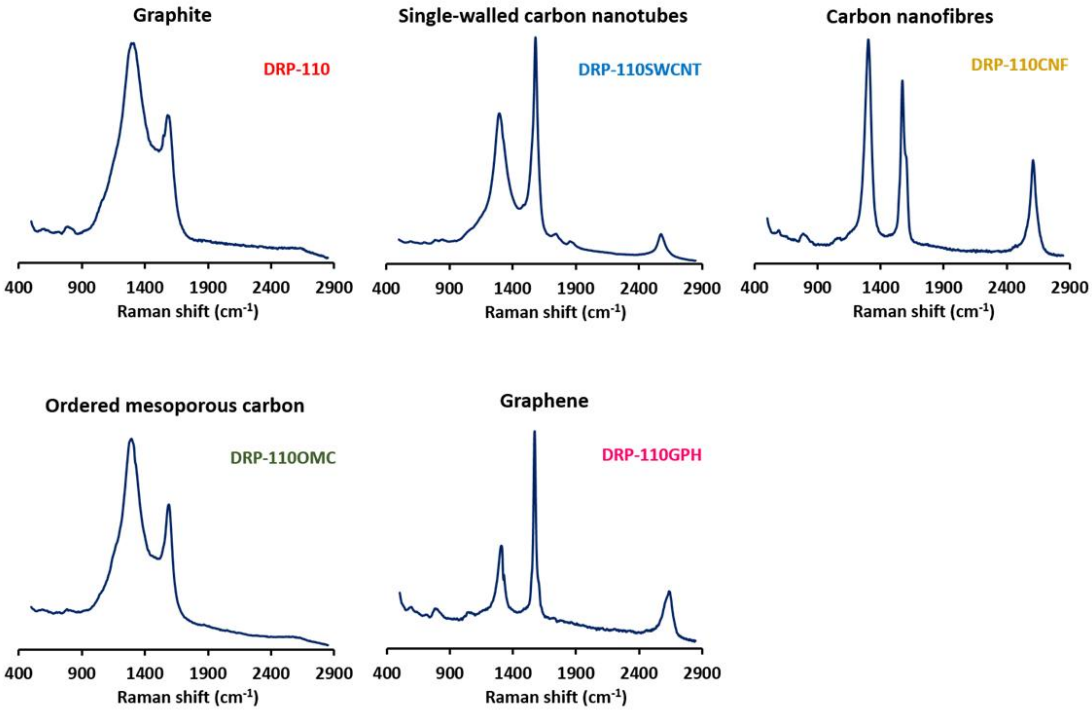
EQUIPMENT

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.



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CONFIGURATION

785 nm
SPELECRAMAN 是一可行光化学拉曼量的器。SPELECRAMAN 将一个 3B 激光器 (785 nm ± 0.5)、一个双恒位/恒流和一个光(波范:787 - 1027 nm,拉曼位移:35 - 3000 cm^{-1})合在一个箱子中,并配有用的光化学件,可同步行光学和化学。

反射探用于激 785 nm 波(高 500 mW)。用于与网印刷 DropSens 拉曼流通池或任何拉曼装置一起工作。

黑色聚四乙反射池,用于网印刷合参考 RAMANPROBE 行拉曼光化学量。

网印刷(助:C;参比:Ag)。 宜合微体行分散定或研特定感器。

壁米管改性网印刷,用于化化学活区域的(生物)感器的研。

多壁米管改性网印刷,用于化化学活区域的(生物)感器的研。

有序介孔改性网印刷,用于化化学活区域的(生物)感器的研。

石墨改性网印刷,用于化化学活区域的(生物)感器的研。

米改性网印刷,用于化化学活区域的(生物)感器的研。