

# Characterization of carbon-based nanostructured materials by Electron Microscopy Techniques

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## INTRODUCTION

The standard light-based microscopes are limited by the inherent limitations of light, and as such their maximum resolving power may reach tenths of microns. Conversely, the electron microscopes can exceed this by far, showing small details until molecular and atomic level.

A traditional microscope uses light and lenses to magnify a given specimen; electron microscopes, as their name suggests, utilize electrons instead. Positive electrical potential is used to send electrons toward the specimen in vacuum conditions, which are then focused using apertures and magnetic lenses. These particular lenses can be adjusted, much like the glass ones, to focus the image. Finally, the beam of electrons interacts with the sample and the products of the reaction can be interpreted, resulting in very detailed images.

Nowadays, electron microscopy investigation is one of the most important and reliable technique for correctly identifying the nature and the form of carbon nanomaterials in academic research and industry. In addition, it provides lots of other valuable information which are discussed in detail by giving suitable examples.

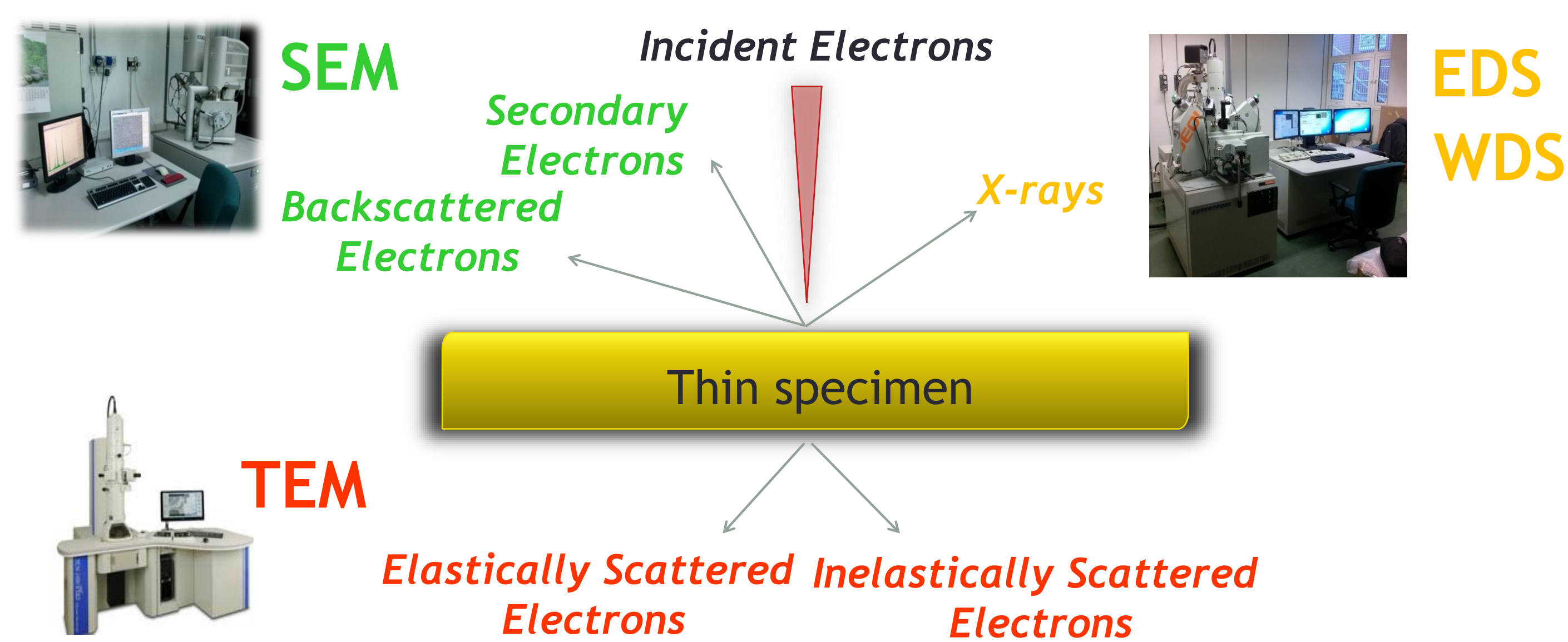
## MOTIVATION

- Understand the working principle of the electron microscopy techniques (SEM and TEM) and, furthermore, learn the correct use of elemental analysis produced by EDS and WDS.
- Analyze the morphological characteristics and chemical composition of carbon-based nanostructured samples, by configuring correctly all parameters that allow to collect these information.

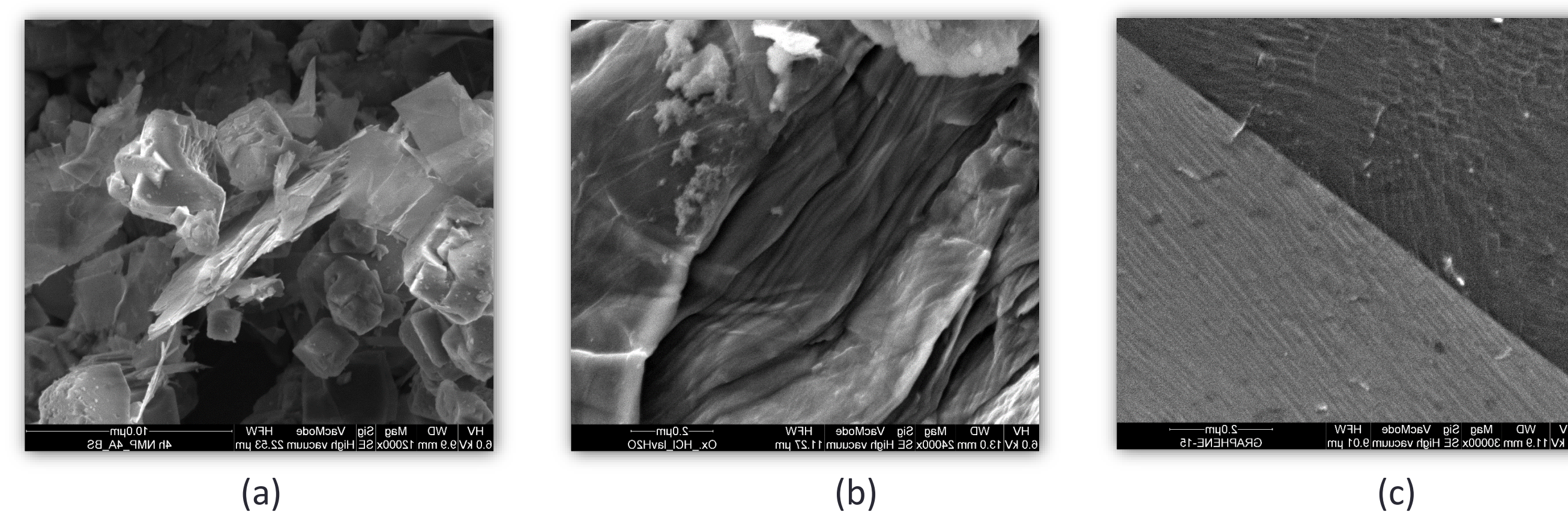
## INSTRUMENTATION AND MATERIALS

- SEM (Scanning Electron Microscopy)
- TEM (Transmission Electron Microscopy)
- EDS (Electron Diffraction Spectroscopy)
- WDS (Wave Diffraction Spectroscopy)
- Carbon Nanostructures

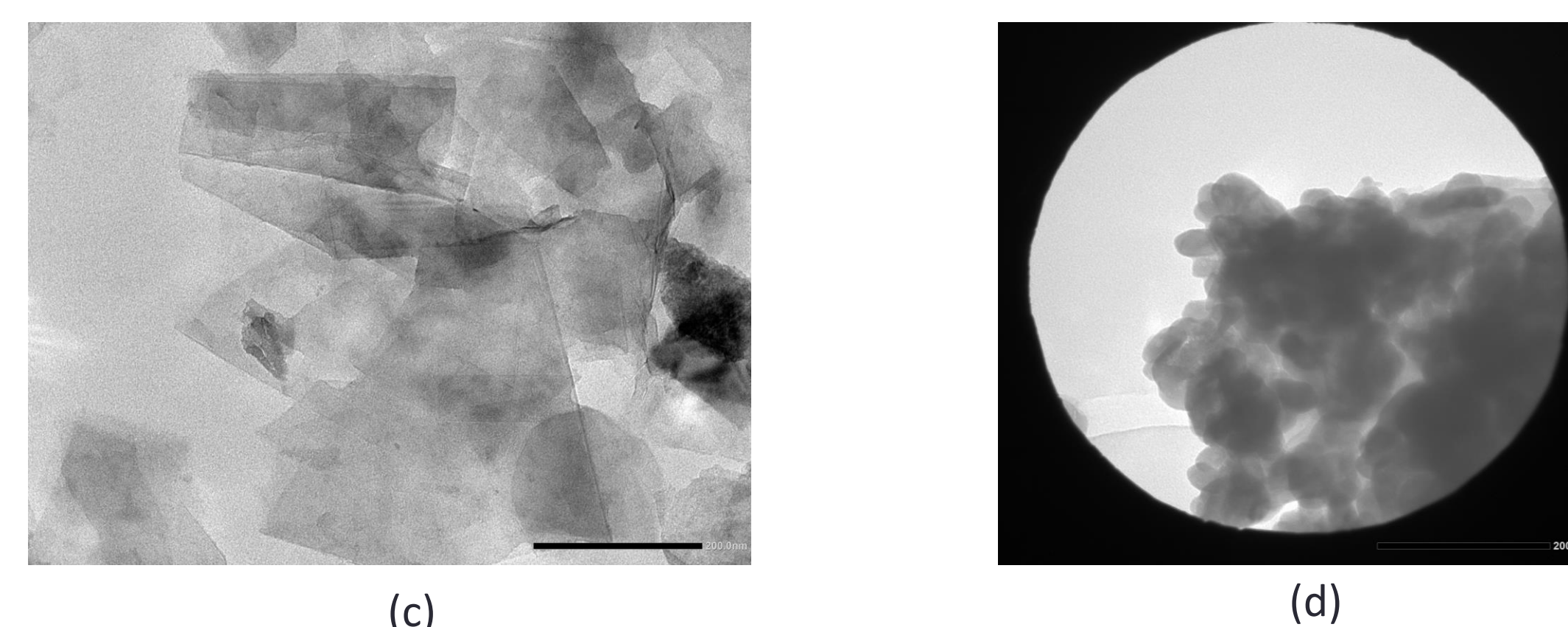
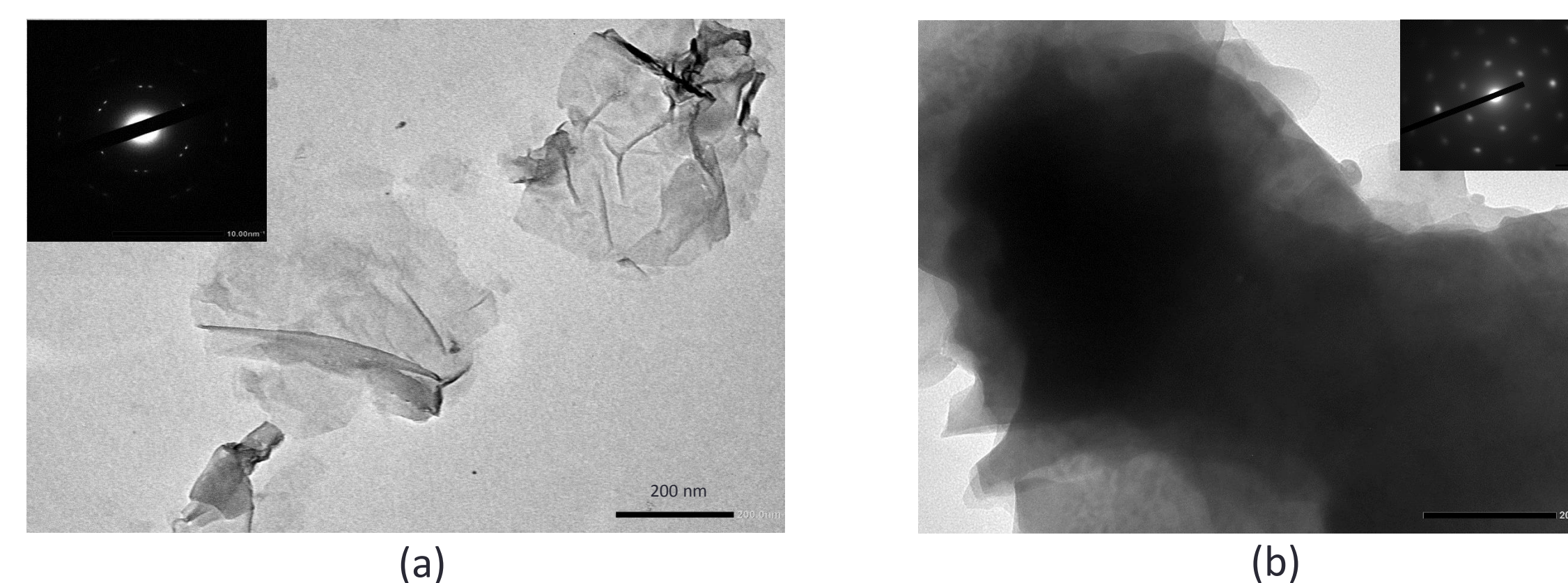
## THEORETICAL AND EXPERIMENTAL SETUP



## RESULTS AND DISCUSSION

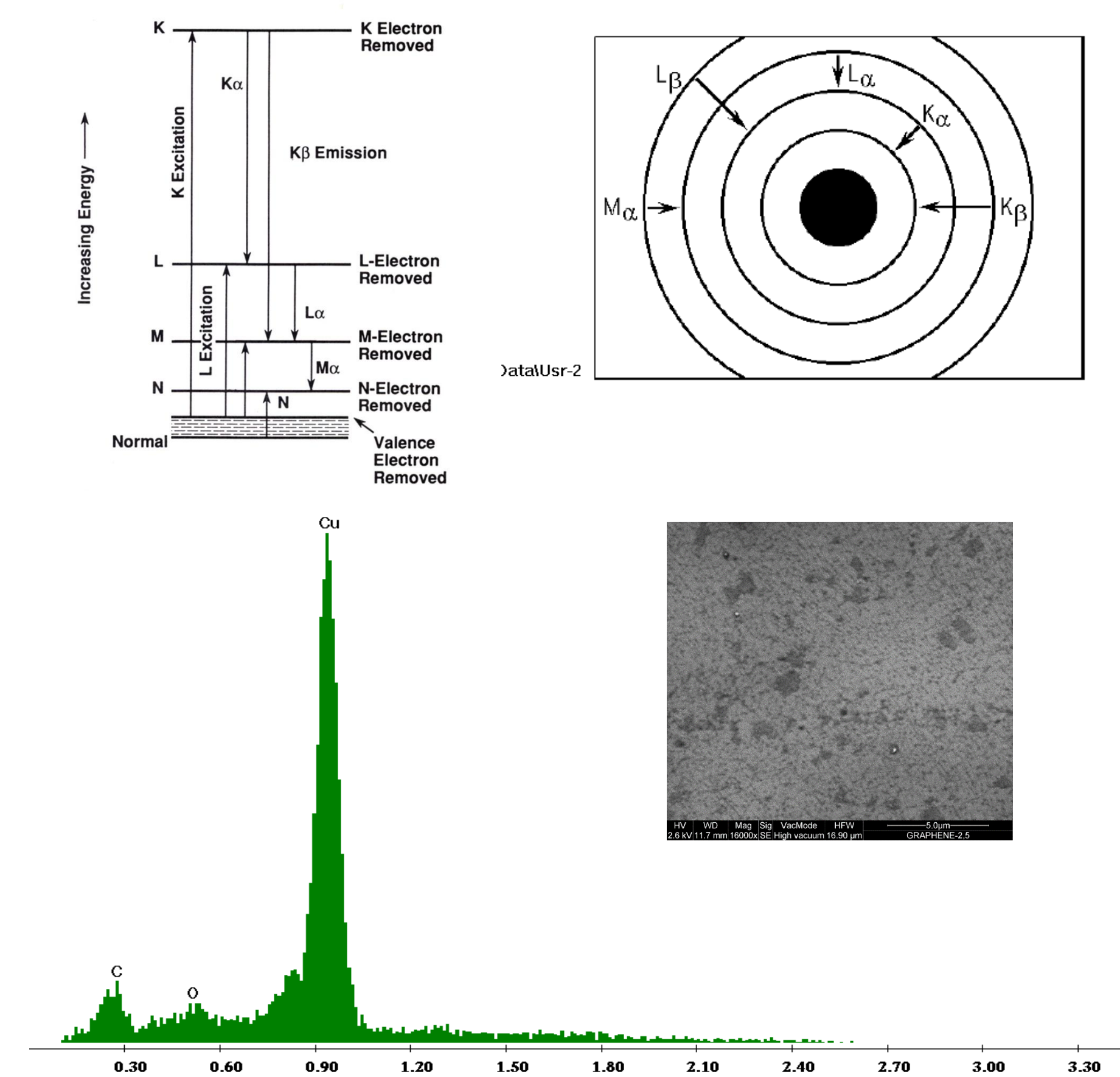


- SEM images of carbon-based nanostructures, (a) Few Layers Graphene (b) Graphite Oxide (c) Monolayer Graphene

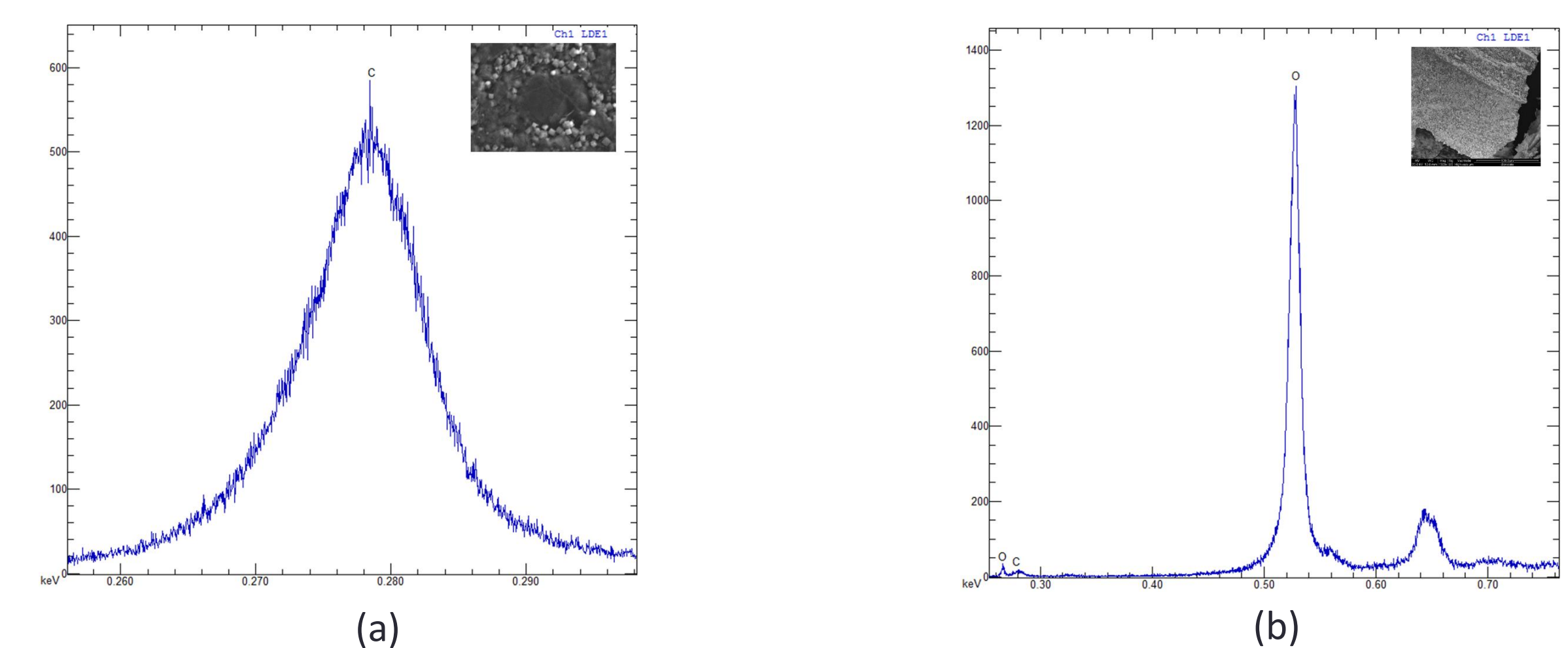
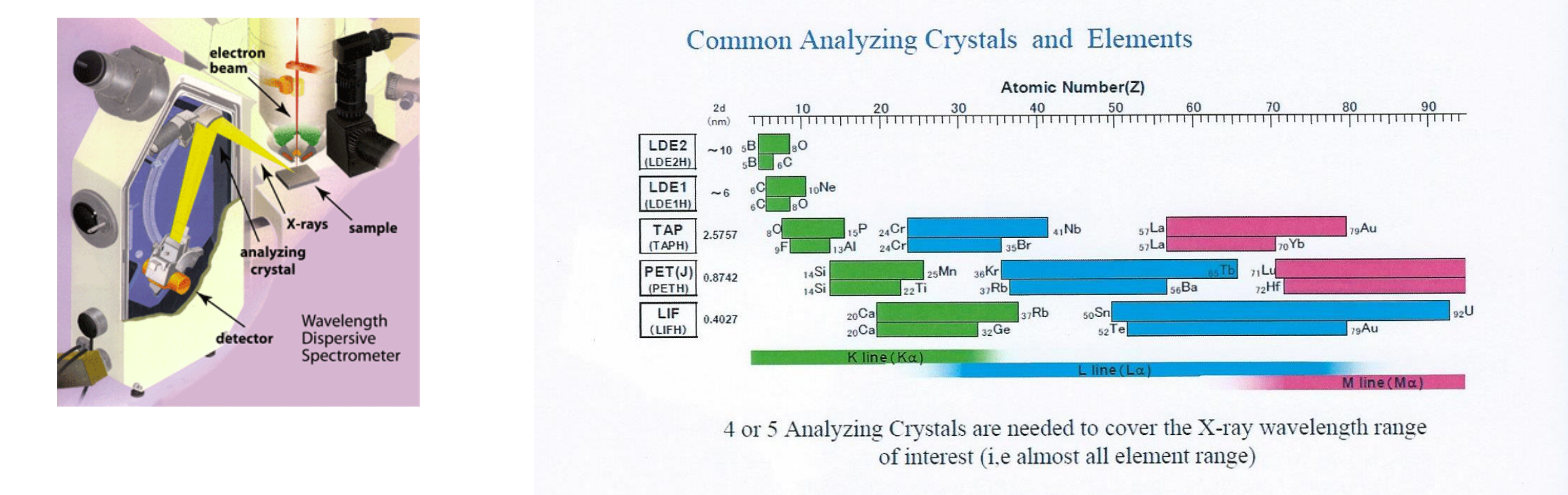


- TEM images of carbon nanostructures, (a) Diffraction pattern of Few Layers Graphene; (b) Diffraction pattern of Graphite Oxide (c) Few layers graphene (d) Defined area to make diffraction pattern of GO

## RESULTS AND DISCUSSION



- EDS analysis of Monolayer Graphene



- WDS analysis of (a) Few layers Graphene (b) Graphite Oxide

## CONCLUSIONS

- The Electron Microscopy techniques are fundamental tools that allow to obtain several information about the particular sample analyzed.
- The morphological information can be obtained by SEM and TEM microscopes. This analysis permit to discriminate the different structures between various carbon nanostructures and other materials.
- EDS and WDS analysis allow to perform a qualitative and quantitative analysis about the chemical composition of the samples studied.