

## Elucidating the chemical depth profile of laser-induced graphene electrodes

Edjan Alves da Silva<sup>1</sup>, Lara Fernandes Loguercio<sup>2</sup>, Marcus V. Castegnaro<sup>1</sup>, Anderson Thesing<sup>1</sup>

<sup>1</sup>Institute of Physics, Universidade Federal do Rio Grande do Sul, Porto Alegre, RS – Brazil

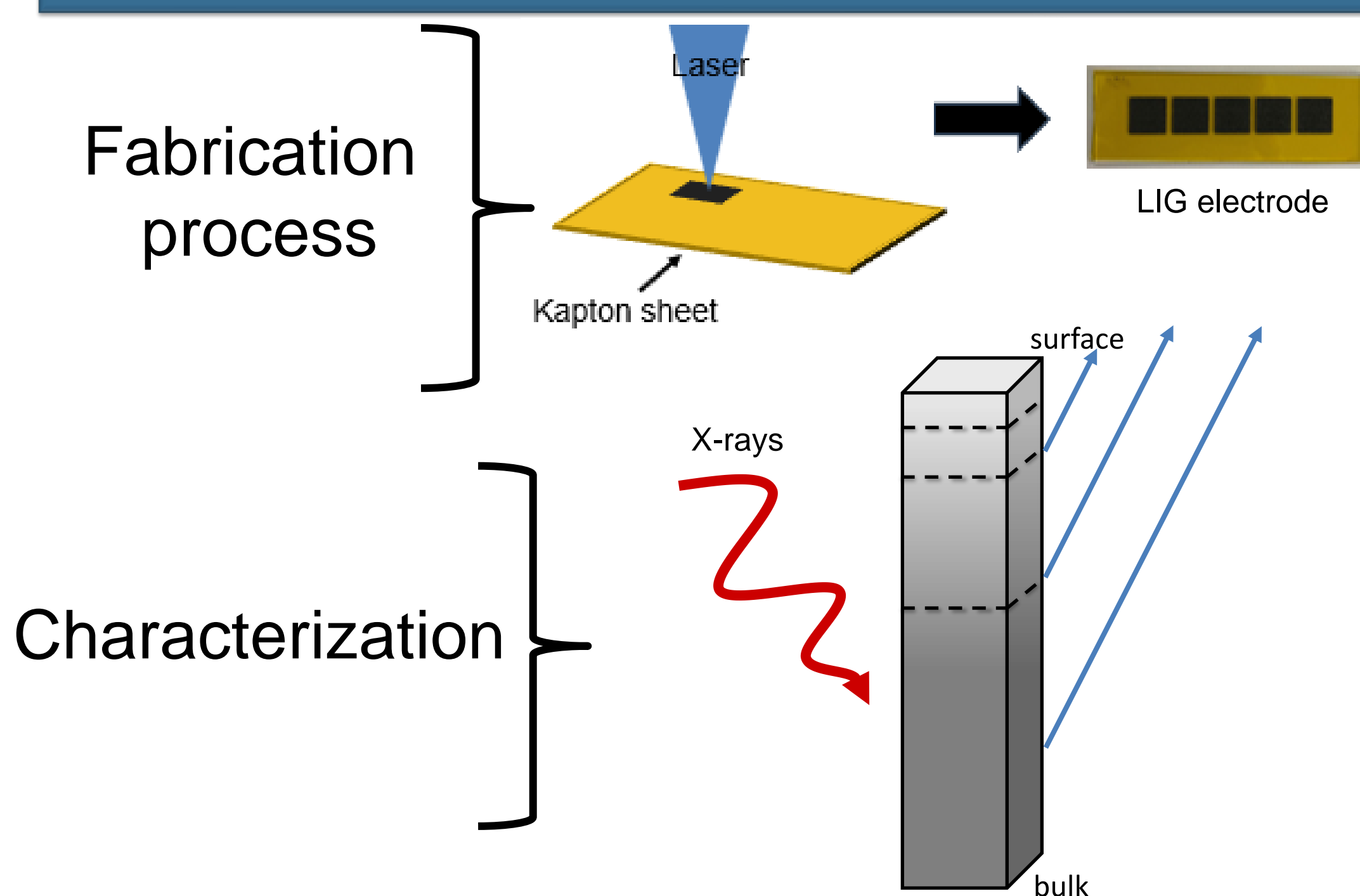
<sup>2</sup>Institute of Chemistry, PRH 50.1, Universidade Federal do Rio Grande do Sul, Porto Alegre, RS - Brazil

### INTRODUCTION

Various strategies are being explored to produce clean and renewable fuels and to efficiently convert their stored energy [1]. Among emerging materials, metal-free three-dimensional (3D) hierarchical porous carbon structures have gained attention as promising candidates for electrocatalytic water splitting. In particular, laser-induced graphene (LIG) electrodes stand out due to their high stability, favorable electronic properties, low resistance, and large surface area [2].

During LIG formation, the heat generated by laser irradiation breaks C–O, C=O, and C–N bonds, releasing gaseous products and promoting the rearrangement of carbon atoms into aromatic structures with  $sp^2$  hybridization. One of the main challenges in advancing these materials lies in understanding their surface chemistry, especially the role of structural defects that enable their functionalization for various applications using synchrotron-based X-ray photoelectron spectroscopy (XPS) [3].

### METHODS



### RESULTS & DISCUSSION

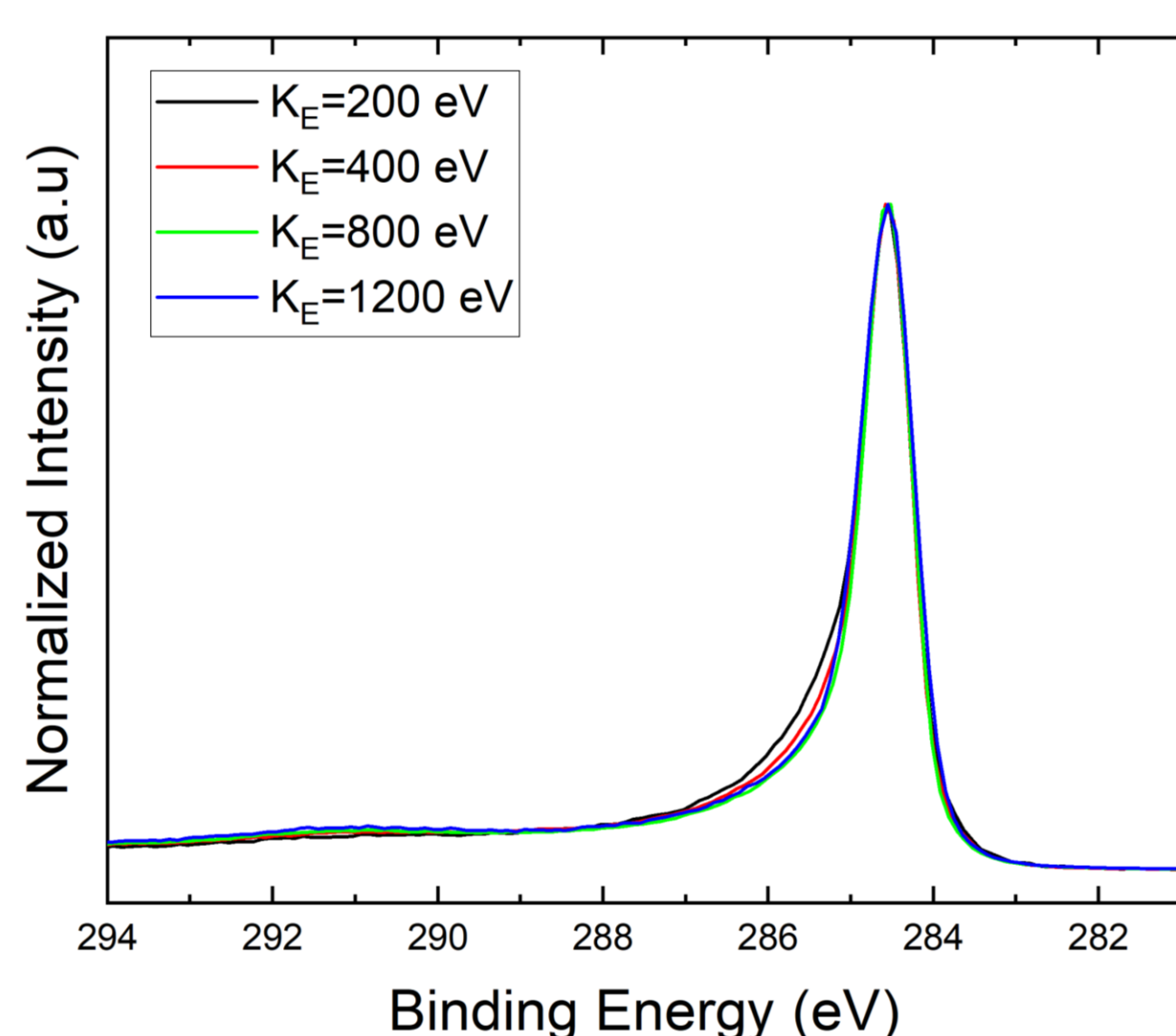


Figure 1 - High-resolution core-level C 1s XPS spectra using different kinetic energies.

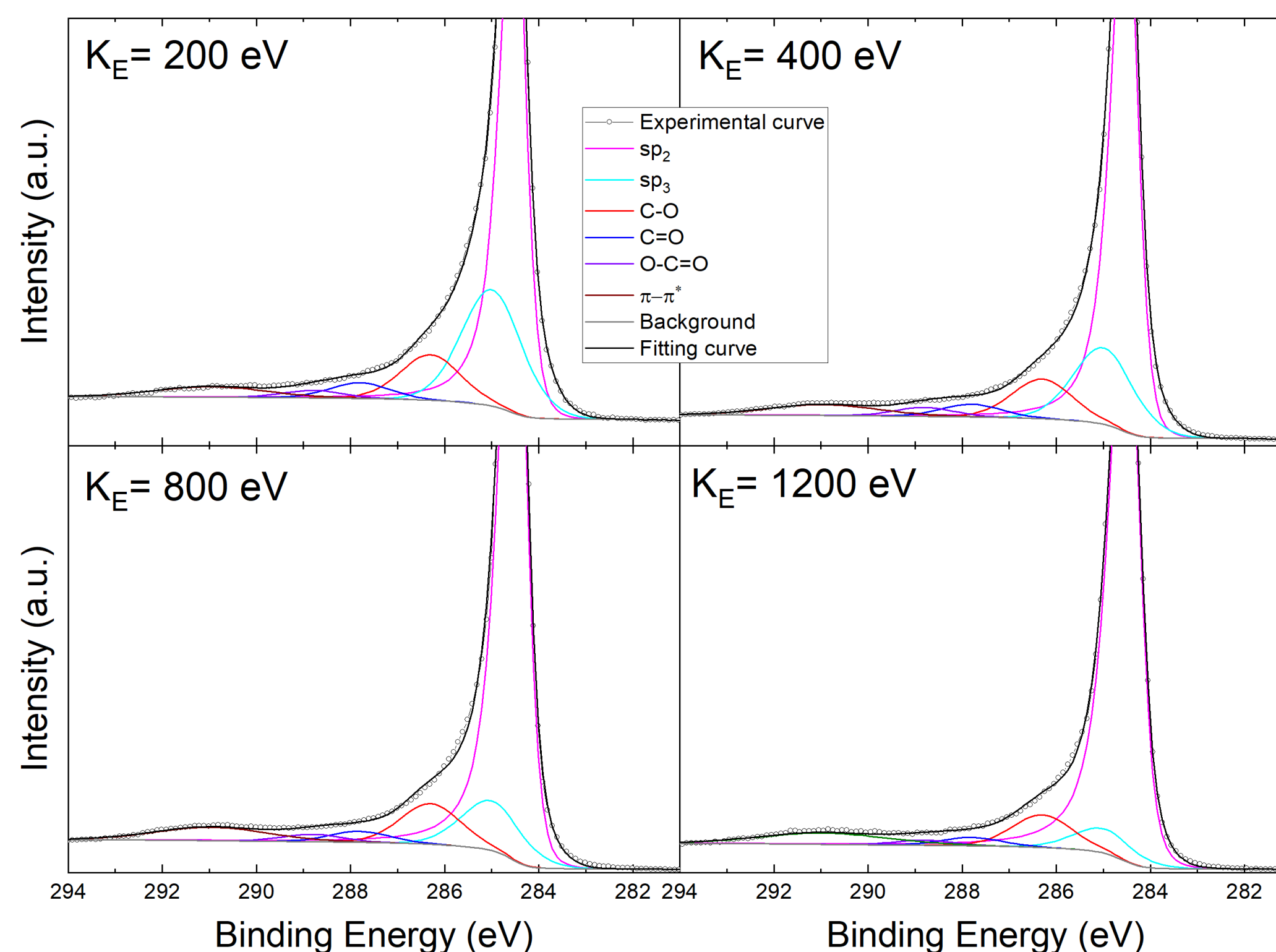


Figure 2 - High-resolution core-level C 1s XPS spectra using different kinetic energies. The deconvoluted C 1s spectra into components show seven peaks associated with different chemical species in the C 1s signal.

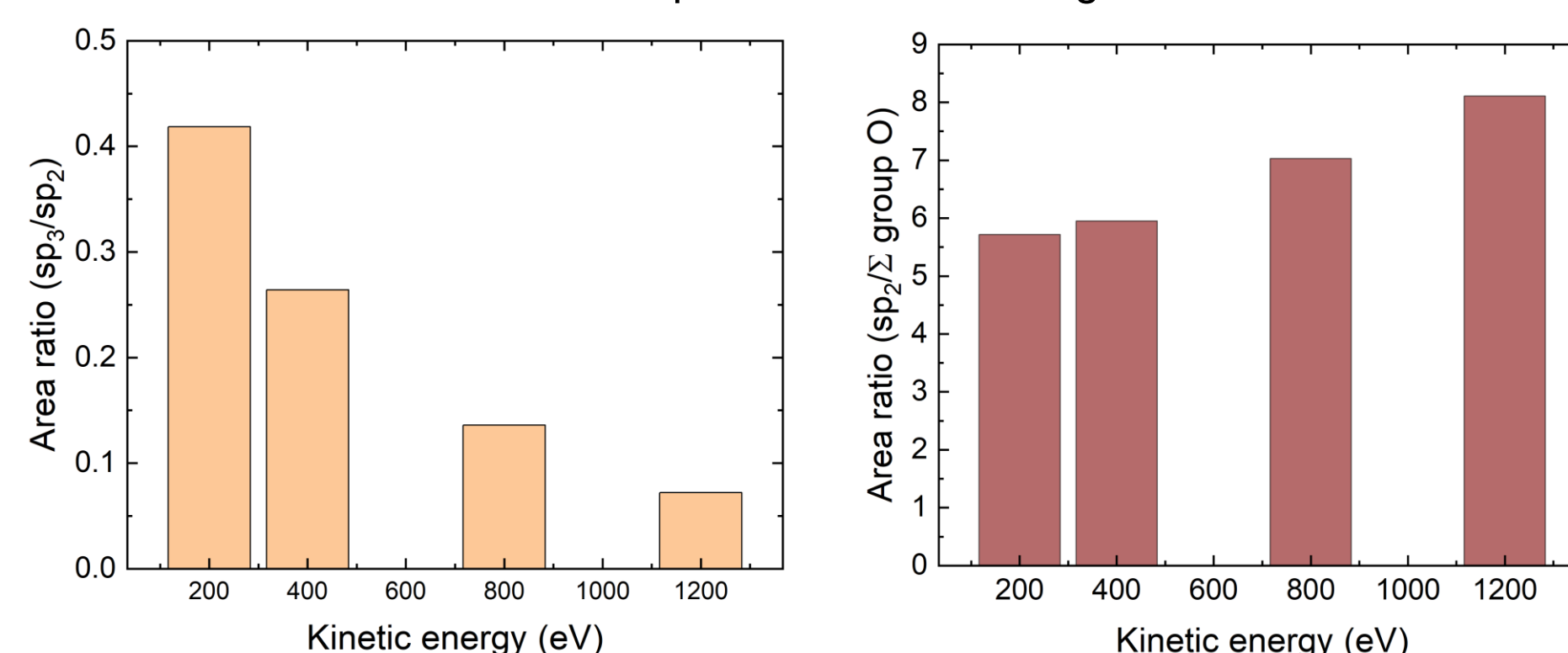


Figure 3- The left panel shows the area ratio of  $sp^3$  to  $sp^2$  at different kinetic energies. The right panel shows the area ratio of  $sp^2$  to the sum of the oxygenated components at different kinetic energies.

### CONCLUSION

I - Fitting of XPS spectra of graphene exhibits decrease in the intensity of the  $sp^3$  (C 1s) component and associated defects with increasing kinetic energy;

II – The contribution of the  $sp^2$  (C 1s) component relative to the total oxygen content increases at higher kinetic energies;

III- XPS quantification reveals not only variations in the surface and sub-surface chemical composition with different laser powers but also corresponding changes in the chemical depth profile.

### REFERENCES

- [1] CHRISTOFORIDIS, Konstantinos C.; FORNASIERO, ChemCatChem, 9, 1523-1544 (2017).
- [2] XIANG, Qianjun; YU, Jiaguo., The Journal of Physical Chemistry Letters, v. 4, 753-759 (2013).
- [3] BIESINGER, Mark C., Applied Surface Science, 597, 153681, (2022).

### ACKNOWLEDGMENTS