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Quantitative Core Level Photoelectron Spectroscopy

A primer

Quantitative Core Level Photoelectron Spectroscopy

A primer

Juan A Colón Santana

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To my father Juan R Colón Infante, a man of great character.

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Preface

I still remember vividly that Tuesday in January 2008. A colleague of mine was kind enough to give me a tour around the facility in which he did research at the time and there it was . . . a photoemission spectroscopy system. I remember preparing diligently for that day. I read articles, several sections in different books and even some presentations from the web. Even though my understanding was limited (as I was merely beginning graduate school), I understood the basic theoretical ideas of the process and felt that I was ready to make the most of the given opportunity. By the end of the tour, three words and perhaps a punctuation mark were in my mind—I will let you guess which words. It was then when I started experiencing the differences between ‘textbook’ science and ‘practical’ science or science as it is done in the laboratory. Please, do not misinterpret my previous statement. The content seen in a textbook plays a huge role in the learning process, but so it does the practical part of it. I went back to my literature search and now instead of assuming that photons are incidents on a material and electrons are ejected (as part of the photoemission process), I found myself learning how the photons are generated and how electrons are detected. If that was not enough, it was also imperative to learn how to manipulate electronics, how to use a water chiller, and how to create vacuum. None of these issues were raised in any of the classes I was taking or soon to take. Once I reached the point in which I felt comfortable with the practical side, I realize that still there was a gap between what I learned in classes and what I learned in the lab. How could I begin filling that gap? It required (and still requires) a lot of effort on my part and the help of many great colleagues who provided me with their experiences and time.

I have been fortunate to be in a position in which I am able to constantly mentor students. It has been interesting to observe that most students are very proficient either at the theoretical side or at the practical side of their field of interest. What about the bridge connecting those two areas? Why is it so difficult for the learner to connect both realms? While I do not intend to provide an answer to that question, I intend to provide the initial steps necessary to make those connections in this work.

Quantitative Core Level Photoelectron Spectroscopy: A Primer is a text intended to provide the reader with the fundamental concepts that comprise the x-ray photoemission spectroscopy technique and connect them to the experimental part of the process. The text has come together based on the uncertainties encountered when initiated to the field, and those encountered by the students or professionals that I have mentored during the years.

I must warn the reader that this is not an advanced text, nor will it provide exhaustive treatment of any topic. Instead, the basic ideas will be presented with numerous references to the advanced stage of the material. This is an introductory text with the aim of providing the basic understanding of the photoemissions process from the perspective of an experimental scientist. The reader should consider this work as a text to use prior to their immersion in the experimental side of x-ray photoemission spectroscopy.

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I am grateful to my wonderful and beloved wife Olha Ketsman—for her unlimited care, patience and support during this process. To my dear family—whose words were an inspiration. In addition, I want to thank Professor Michael Nastasi for providing me with his support and the valuable time necessary for me to finish this text. I also would like to thank the students and professionals that I had the honor to supervise and interact with throughout the years. They provided me with the platform on which this work lies. Thank you to my friend Elena Echeverria Mora for her help and feedback regarding this work. I am in debt to Professor Peter Dowben (who for some reason always ends last on the list)—a mentor, a role model and a dearest friend, who has been a great help in the development of this work and who has taught me invaluable lessons in the complex field of life.

Author biography

Juan A Colón Santana

Juan A Colón Santana, obtained his PhD in Electrical Engineering from the University of Nebraska Lincoln in 2012. He has contributed to the fields of magnetism and radiation with a total of 24 publications and one patent. Juan was nationally recognized for his work on oxides by winning prestigious awards such as the Leo Falicov award. He is currently a Research Associate in the Department of Physics at Northern Illinois University where he is involved in research, teaching and outreach activities.