Preface

Electrostatics is now in its second decade of great activity that challenged well-established ideas substituting them for new concepts. As it often happens in science, this was made possible by new experimental tools like the scanning probe microscopes and scanning electrodes that produce 3D plots of charge, potential, capacitance, or conductance at solid and liquid surfaces. Another factor for change was the dissemination of other experimental tools like the noncontact electrostatic probes that measure electrostatic potential.

Researcher attitudes also changed and many decided to follow a suggestion made by Whitesides, accepting that macroscopic systems under equilibrium or quasi-equilibrium states may carry excess charge thus producing finite electric potential in their vicinity. The triboelectric series is another concept that was challenged, when macro- and microscopic potential maps showed that charge distribution on insulator surfaces is nonuniform, often following fractal patterns.

A major conceptual change is the recognition of the role of ions as charge carriers in a large number of important electrostatic phenomena. This is the result of many laboratory experiments and field results in different research disciplines, allowing researchers and engineers to benefit from a large amount of chemical knowledge to understand well-known but hitherto challenging phenomena. It is now possible to describe "space charge" in terms of ions and electrons, largely increasing the accuracy of the descriptions of the involved phenomena.

The atmosphere was acknowledged as the site of many phenomena producing electricity and this is related to water that assumes a paramount role in electrostatic phenomena. Water was previously seen as an agent for the dissipation of charge on electrified surfaces, due to its weak but non-negligible conductivity. Opposite to that, its ability to impart charge to solid surfaces is now recognized and it is extensively discussed in Chap. 6 of this book, on Hygroelectricity.

Triboelectricity is receiving a firmer mechanistic basis, since charge carriers in tribocharged polymers were identified as ionic species formed during mechanochemical reactions. Coupled to the demonstration that charge abatement on electrified polymer surfaces is also related to water adsorption, it can now be much better studied.

Another contribution came from acknowledging that many important metals are coated with a layer of oxide with low intrinsic conductivity. This also helped to understand interesting electrostatic phenomena in isolated metal objects.

The recent surge in the science of Electrostatics is thus due to new and often unexpected results that are being slowly examined, criticized, and absorbed by scientists and engineers. This new situation was not created by any bright new theory or by a single breakthrough that illuminated the way for scientists and engineers. For this reason, it is not easily captured by reading separate papers that contain a small but nevertheless essential part of the history. Moreover, there are a large number of papers and reports on various phenomena that were not followed up in the literature, remaining as valuable but uncorrelated and often forgotten pieces of information. These papers come from many different scientific disciplines, with different approaches, methodologies, and outlook.

This book is a systematic presentation of recent developments in Electrostatics, emphasizing those that are really new additions to the many excellent books that treat this subject in a more formal and abstract way. Recent developments are correlated to previously scattered experimental information that hitherto was considered too empirical to be considered in reference books. Recent and previous information is reported and discussed with an emphasis on physico-chemical and chemical events, whose elucidation is providing a better understanding of Electrostatics. This is why this book is named *Chemical Electrostatics.* Some readers may miss the abundance of mathematical equations often found in books and book chapters on Electrostatics. This is a deliberate choice of the authors, who did not want to repeat the contents of previous, excellent books.

Even though there is an emphasis on chemical and physico-chemical phenomena, chemical equations were kept to a minimum, acknowledging that chemical language is not familiar to many "hard" scientists and engineers.

Well-established concepts are used throughout the book, like pK and zeta potential, adsorption, electronegativity, electrical double layer, and many others that may not be familiar to some readers. The authors opted for not making specific introductions to them because this would largely lengthen the text. Moreover, these concepts are treated in detail in many reference books and in valuable materials accessible through the Internet. The authors strongly encourage readers to get well acquainted with those more basic concepts, whenever they feel they need it.

Chemistry made an invaluable contribution to our understanding of electrostatic phenomena and this will probably continue, for the foreseeable future. Chemistry is complex, the same as Nature. It is not amenable or properly explained by any encompassing theoretical approach; neither are most chemical phenomena predictable by any single theory. Given the importance of chemical phenomena to Electrostatics, the same applies to this discipline.

The authors expect that this phenomenological presentation will help researchers and engineers to devise new and better ways to reach some practical objectives. One is to increase human and property safety, avoiding undesirable consequences of electrostatic discharges, as discussed in Chap. 12. Chapter 13 presents new functional materials that can perform currently or previously unimaginable tasks, added to new products and processes to better human life, in a greener world.

Electrostatics has some appealing "green" features: large effects are produced using a few Joules, while great changes in the behavior of matter are obtained by adding or removing minute amounts of water. These features will allow Electrostatics to play a major role, in the quest for sustainability.

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