

Review of Scientific Paper “Contact Electrification Using Force Microscopy”

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Abstract — Charge exchange is a mechanism previously explored and theorized about for thousands of years by macroscopic level observation and instrumentation which has proven insufficient. This paper reviews a technique which approaches the problem using a higher resolution method to track and measure charge states on materials.

Index Terms — Triboelectric, charge microscopy, metal-insulator contact, force microscope

I. BACKGROUND AND INTRODUCTION

The paper “Contact Electrification Using Force Microscopy” describes a new methodology in order to more closely study the process of exactly how charges are exchanged between two different materials that come into physical contact with each other. This property, known as the triboelectric effect, has been observed since the days of a particular Greek scholar known as Thales of Miletus (6th – 7th Century BC) who observed the electrification of materials rubbed with amber. It was he who first coined the word electricity from the Greek work for amber: “elektron”.¹⁰

The types of triboelectrification are broadly divided into the metal on metal, metal on insulator and insulator on insulator. In the work of J.R. Harper during the 1960’s, it was discovered that when two metals touch, the charge is equalized when the Fermi levels of the respective materials match each other.⁹ However in the case where at one or both of the materials is insulating, the process of charge exchange has been controversial.

Some researchers claimed that only the last metal touched determined the net charge on the insulator whereas others apparently observed a cumulative effect with each metal contact. Discerning which theory is correct depends on understanding how the individual charge sites work which has been a problem of area resolution. These experiments were conducted at relatively macroscale (millimeter) regimes which can suffer from net charge inaccuracies. The findings of this

paper have found further information that can only be discerned with measurements on a smaller scale.

The modified force microscope employs a piezo-electrically driven lever on which is mounted a thin nickel wire that has been bent 90 degrees downward to an electrochemically etched tip. The piezo element is driven by an oscillator at just above 2.5 kHz with part of the signal being split into a lock-in amplifier which compares the phase of the signal with that of an optical interferometer sensor that monitors the movement of the lever/tip assembly.

While in operation, the tip is oscillated at just above the resonant frequency (as approaching the surface begins to change the spring constant and dampen the movement) while the AC bias frequency is kept below the tip frequency (to avoid constructive interference in the signal to the Servo Electronics) but above the feedback loop frequency response rate,¹ (probably to avoid creating a false reinforcement in the feedback loop which could cause unpredictable or uncontrollable behavior and oscillation.)

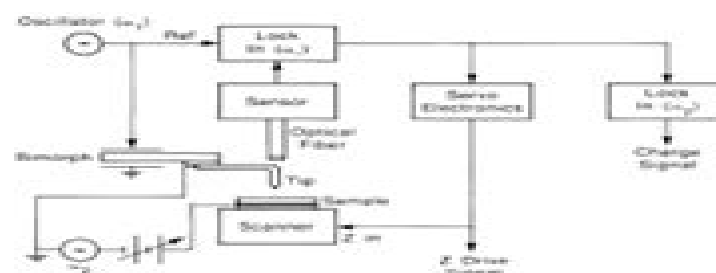


FIG. 1. Block diagram of the force microscope.

FIG. 1. Force Microscope Block Diagram from Reference [1]

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Science, Technical Systems, and Cooperative Work Geoffrey Bowker, Susan Leigh Star, Les Gasser, William Turner, 2014-05-12 This book is the first to directly address the question of how to bridge what has been termed the great divide between the approaches of systems developers and those of social scientists to computer supported cooperative work a question that has been vigorously debated in the systems development literature Traditionally developers have been trained in formal methods and oriented to engineering and formal theoretical problems many social scientists in the CSCW field come from humanistic traditions in which results are reported in a narrative mode In spite of their differences in style the two groups have been cooperating more and more in the last decade as the people problems associated with computing become increasingly evident to everyone The authors have been encouraged to examine rigorously and in depth the theoretical basis of CSCW With contributions from field leaders in the United Kingdom France Scandinavia Mexico and the United States this volume offers an exciting overview of the cutting edge of research and theory It constitutes a solid foundation for the rapidly coalescing field of social informatics Divided into three parts this volume covers social theory design theory and the sociotechnical system with respect to CSCW The first set of chapters looks at ways of rethinking basic social categories with the development of distributed collaborative computing technology concepts of the group technology information user and text The next section concentrates more on the lessons that can be learned at the design stage given that one wants to build a CSCW system incorporating these insights what kind of work does one need to do and how is understanding of design affected The final part looks at the integration of social and technical in the operation of working sociotechnical systems Collectively the contributors make the argument that the social and technical are irremediably linked in practice and so the great divide not only should be a thing of the past it should never have existed in the first place

Virtual Reality and Augmented Reality Jernej Barbic, Mirabelle D'Cruz, Marc Erich Latoschik, Mel Slater, Patrick Bourdot, 2017-12-06 This book constitutes the refereed proceedings of the 14th International Conference on Virtual Reality and Augmented Reality EuroVR 2017 held in Laval France in December 2017 The 10 full papers and 2 short papers presented were carefully reviewed and selected from 36 submissions The papers are organized in four topical sections interaction models and user studies visual and haptic real time rendering perception and cognition and rehabilitation and safety

Sampling for Measurement of Odours Peter Gostelow, Philip J. Longhurst, Simon Parsons, Richard M. Stuetz, 2003-05-31 Research into the sampling and measurement of odours has developed in a number of sectors especially the agriculture food and process industries with knowledge from each sector being transferred to the wastewater and solid waste management sectors Progressive developments in odour research have resulted in researchers re tracing original research studies to understand the contribution and variability of differing sampling and measurement techniques There are however very few reviews that compile earlier studies across each sector This study looks at the information used to support current practices in odour sampling and measurement for impact reduction Sampling for Measurement of Odours reviews European and other internationally available research studies to understand odour sampling and measurement practice in waste applications The emphasis is placed on appropriate odour sampling and its relationship to differing measurement techniques As recent developments in standardisation of odour measurement have reduced much of the variation and identified best practice in this area there is at present a far greater variation in sampling techniques with serious implications for the quality of samples obtained and their usefulness for assessing odour impact The review considers the available information on uncontrolled area sources identifies factors influencing sample losses or transformations and looks at information on the sources of variability identified through standardisation programmes This need for this report was identified by the Odour Network an EPSRC sponsored discussion platform intended to promote multidisciplinary research in the areas of odour measurement modelling and treatment Scientific and Technical Report No 17

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 - The Rise of Digital Reading Scientific Technical Papers
 - Advantages of eBooks Over Traditional Books
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 - Exploring Different Genres
 - Considering Fiction vs. Non-Fiction
 - Determining Your Reading Goals
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 - Popular eBook Platforms
 - Features to Look for in an Scientific Technical Papers
 - User-Friendly Interface
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 - Scientific Technical Papers User Reviews and Ratings
 - Scientific Technical Papers and Bestseller Lists
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 - Highlighting and Note-Taking Scientific Technical Papers
 - Interactive Elements Scientific Technical Papers
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 - Joining Online Reading Communities
 - Participating in Virtual Book Clubs
 - Following Authors and Publishers Scientific Technical Papers
- 9. Balancing eBooks and Physical Books Scientific Technical Papers
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 - Creating a Diverse Reading Collection Scientific Technical Papers
- 10. Overcoming Reading Challenges
 - Dealing with Digital Eye Strain
 - Minimizing Distractions
 - Managing Screen Time
- 11. Cultivating a Reading Routine Scientific Technical Papers
 - Setting Reading Goals Scientific Technical Papers
 - Carving Out Dedicated Reading Time
- 12. Sourcing Reliable Information of Scientific Technical Papers
 - Fact-Checking eBook Content of Scientific Technical Papers
 - Distinguishing Credible Sources
- 13. Promoting Lifelong Learning
 - Utilizing eBooks for Skill Development
 - Exploring Educational eBooks

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- Integration of Multimedia Elements
- Interactive and Gamified eBooks

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