

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.)

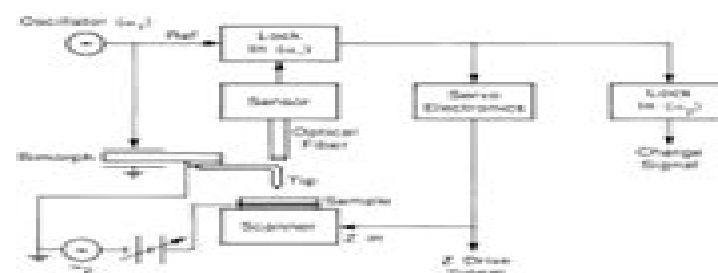


FIG. 1. Block diagram of the force microscope.

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

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Computational Science - ICCS 2020 Valeria V. Krzhizhanovskaya, Gábor Závodszky, Michael H. Lees, Jack J. Dongarra, Peter M. A. Sloot, Sérgio Brissos, João Teixeira, 2020-06-18 The seven volume set LNCS 12137 12138 12139 12140 12141 12142 and 12143 constitutes the proceedings of the 20th International Conference on Computational Science ICCS 2020 held in Amsterdam The Netherlands in June 2020 The total of 101 papers and 248 workshop papers presented in this book set were carefully reviewed and selected from 719 submissions 230 submissions to the main track and 489 submissions to the workshops The papers were organized in topical sections named Part I ICCS Main Track Part II ICCS Main Track Part III Advances in High Performance Computational Earth Sciences Applications and Frameworks Agent Based Simulations Adaptive Algorithms and Solvers Applications of Computational Methods in Artificial Intelligence and Machine Learning Biomedical and Bioinformatics Challenges for Computer Science Part IV Classifier Learning from Difficult Data Complex Social Systems through the Lens of Computational Science Computational Health Computational Methods for Emerging

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Pharmaceutical Practice E-Book Arthur J. Winfield, Judith Rees, Ian Smith, 2009-07-21 This comprehensive book covers a wide range of subjects relevant to pharmacy practice including communication skills managing a business quality assurance dispensing calculations packaging storage and labeling of medicines sterilization prescriptions hospital based services techniques and treatments adverse drug reactions pharmacoeconomics and medicines management Features useful appendices on medical abbreviations pharmaceutical Latin terms weights and measures and presentation skills This is a core text for pharmacy practice and dispensing modules of the pharmacy curriculum Covers key exam material for essential review and test preparation Features a user friendly design with clear headings chapter summaries helpful boxes and key points Text restructured with 14 new or radically revised chapters All text revised in light of current pharmaceutical practice New design using two colours Climate Change Research and Scientific Integrity United States. Congress. Senate.

Committee on Commerce, Science, and Transportation, 2010 **Scientific Writing and Communication in Agriculture and Natural Resources** P.K. Ramachandran Nair, Vimala D. Nair, 2014-01-03 The purpose of this book is to help early career professionals in agriculture and natural resources write their research papers for high quality journals and present their results properly at professional meetings Different fields have different conventions for writing style such that the authors of the book have found it difficult to recommend to young scientists in these fields a specific book or source material out of the several that are available as the go to guide Writing a scientific paper is a tedious task even to experienced writers but it is particularly so for the early career professionals such as students trainees scientists and scholars in agriculture and natural resources the challenge is even more when their first language of communication is not English This book is targeted mainly to that group *Japan's Triple Disaster* Natalia Novikova, Julia Gerster, Manuela G. Hartwig, 2023-06-09 The authors of this volume discuss questions of disaster and justice from various interdisciplinary vantage points including public policy science and technology studies law gender sociology and psychology social and cultural anthropology town planning and tourism The term natural disasters is a misnomer cataclysmic natural events that impact humans can often be anticipated and their

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Writing in European Higher Education Lennart Björk, Gerd Bräuer, L. Rienecker, Peter Stray Jørgensen, 2005-12-30 DAVID RUSSELL English Department of Iowa State University U S A I was fortunate to attend as a visitor from the U S the first European Association for the Teaching of Academic Writing EATAW conference in 2001 at Groningen I was struck by the similarities in the challenges higher education faces on both sides of the Atlantic in terms of developing students academic writing and students learning through writing It is indeed an international problem But I was equally struck by the profound differences in responding to these challenges among institutions disciplines and even within disciplines The essays in this extraordinary volume address a growing demand for help with academic writing on the part of students and academic staff alike And they do so in ways that bring fresh approaches not only to Europeans who have only recently begun to study academic writing but also to researchers and academic staff in the U S where we have a century old tradition of attention to the problem but are much in need of these fresh approaches Academic writing has become a problem in higher education all around the world because higher education sits smack between two contradictory pressures On one end far more students and far more diverse students come streaming into higher education bringing in a far greater diversity of linguistic resources often interpreted as standards are falling as Frank Haacke Tente point out *Bulletin of the Atomic Scientists*, 1983-08 The Bulletin of the Atomic Scientists is the premier public resource on scientific and technological developments that impact global security Founded by Manhattan Project Scientists the Bulletin's iconic Doomsday Clock stimulates solutions for a safer world

Maintaining the Integrity of Scientific Research United States. Congress. House. Committee on Science, Space, and Technology. Subcommittee on Investigations and Oversight, 1990 English for IT Communication Tony Myers, Jaime Buchanan, 2024-11-29 English for IT Communication provides a comprehensive introduction for students and professionals studying IT or computer science and covers all forms of technical communication from emails and memos through procedures to reports and design specs In each case the book offers multiple real world examples looking at who the texts are written for what their purpose is and how these affect what is on the page Key features of this book include How to write for different audiences and purposes How to design documents for ease of access and understanding How to

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