

Review of Scientific Paper “Contact Electrification Using Force Microscopy”

Joel-Anthony Gray, B.S.E.E. Nanoscience Minor - University of Texas at Dallas

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.)

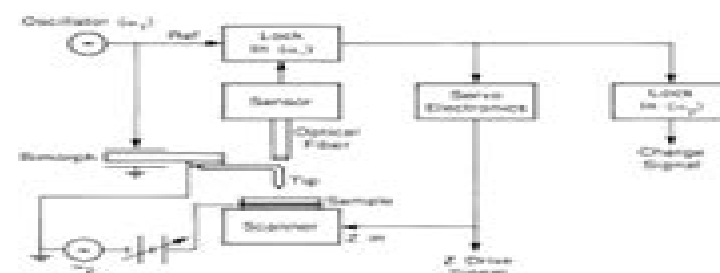


FIG. 1. Block diagram of the force microscope.

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

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web the objective of this block is to make you understand about the major components of the diesel engine as per the following details construction manufacturing process salient features and required dimensional accuracy in the key areas assembling technique and their inspection procedure failure analysis of components structure introduction

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web the banaras locomotive works blw formerly diesel locomotive works dlw in varanasi india is a production unit of indian railways dlw stopped manufacturing diesel locomotives in march 2019 and was renamed blw in oct 2020 2 history founded in 1961 as the dlw it rolled out its first locomotive three years later on 3 january 1964

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locomotive fleet started at a regular pace

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web the alco dl560c is a series of diesel electric locomotive with ac electric transmission designed by the american locomotive company and produced under license by banaras locomotive works blw varanasi india for indian railways as their classes wdm 2 wdm 3a 2c wdm 3d and wdg 3a for operation in india

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web the indian railways primarily operates a fleet of electric and diesel locomotives along with several compressed natural gas cng locomotives steam locomotives are operated on a few world heritage sites and also run occasionally as heritage trains a locomotive is also known as a loco or more popularly as an engine

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web heritage inventory of indian railways diesel electric locomotives s no details location railway 1 wag5 clw 23000 built

1984 els bhusawal cr 2 wam4 clw 21399 built 1983 els bhusawal cr mg diesel loco no ydm4 6200 mysuru rail museum swr 83
ng diesel loco no 158 khurai wcr 84 zdm5 502