

The Electron and Electric Charge

A New Perspective

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Short History of the Electron

- **1897** Discovered by Thompson
- **1909** Charge determined by Millikan
 - The smallest unit of charge until the construct of the quark in the 1960's
- **1932** Positively charged electron discovered by Anderson (dubbed the “positron”)
 - The origin of the idea of antiparticles (mainly because of the Dirac equation with its negative energy solutions)

The Ultimate Green Energy Source

The Solution

Particle –Antiparticle Annihilation

100% Mass to Energy Conversion

(specifically looking at electron – positive electron (positron) interaction)

No radioactivity (or transmutation) and no CO₂ emitted

The Problem

A viable (inexpensive) source of positive electrons

(as well as the efficient use of the gamma rays emitted in the process)

Known Sources for Positrons

- **High Energy Particle Collisions**
 - Cosmic Rays – led to the discovery of the positive electron (Anderson, 1932)
 - Accelerators
- **β^+ decay of radioactive isotopes (^{22}Na)**
- **High Power Laser Interactions with Materials**
 - Gold target – recent work produced record quantities

None of these are a viable inexpensive solution

Re-evaluating the Electron & Charge

Edwin Land (Polaroid) once expressed the following:

“Discoveries are made by some individual who has freed himself from a way of thinking that is held by friends and associates who may be more intelligent, better educated, better disciplined, but who have not mastered the art of the fresh, clean look at the old, old knowledge.”

The nature of the electron and electric charge may need a “fresh, clean look.”

The Discovery of the Positive Electron

A Different Interpretation

What if the Dirac Equation with its negative energy interpretation did not exist?

What would the discovery of the positive electron imply?

- Either we would assume
 - it to be a separate distinct entity
 - or **that the sign of the charge (charge state) of an electron is not a fixed property but can be changed under conditions to be determined.**
- Recent unusual discoveries may support the latter view

The influence of the Dirac equation may have misled physics since the early 1930's

Recent “Strange” Discoveries

- Fractional Quantum Hall Effect (FQHE)
 - Fractionally charged quasiparticles or composite fermions proposed
- High Temperature Superconductivity
 - Layered structures – electron motion limited to 2-dimensional planes
- Electrochemically generated excess heat
 - Unfortunately initially dubbed “cold fusion”

Fractional Quantum Hall Effect (FQHE)

- Experimental Conditions
 - Electrons confined to 2-dimensions
 - Temperature near absolute zero
 - Strong magnetic field perpendicular to electron plane
- Theory
 - Fractionally charged quasiparticles (composite fermions)
 - SIMPLER Approach – possibly a fraction of the electrons have become positively charged
 - this would imply the gamma ray signature of annihilation should be present (a good, but not necessarily easy, test)

High Temperature Superconductivity

- Generally tend to be layered structures
- Still no theory after 24 years
- Perhaps a new property for the electron could help
 - If the electron's charge state can be altered, this could help to explain how it could traverse the electric fields present in the layered structures without loss (charge coupling and oscillation)

Electrochemically Generated Excess Heat

- There have been enough successful experiments to establish the phenomenon
- The cause remains uncertain
 - The claim of “cold fusion” or low energy nuclear reactions (LENR) remains controversial and has marginalized this real effect
 - Could annihilation (due to some of the electrons becoming positively charged) be an alternate explanation?

Electron-Positron annihilation might not be less controversial, but a much more plausible explanation

Annihilation Gamma Ray Signature

- It has been established that gamma ray emission accompanies excess heat production
- The presence of .511 MeV or 1.02 MeV gamma rays would support an annihilation mechanism
- Unfortunately, no measurements of spectra below 1.2 MeV seem to exist

Electrochemical Excess Energy

Long incubation period usually needed before the beginning of excess energy

- Recent microscopic examination of the electrode surface has possibly shown why
- Morphology changes indicate areas that could constrain electron motion allowing the surrounding cations' electric field to possibly flip the electron's charge state to positive

SEM Photo of Cathode

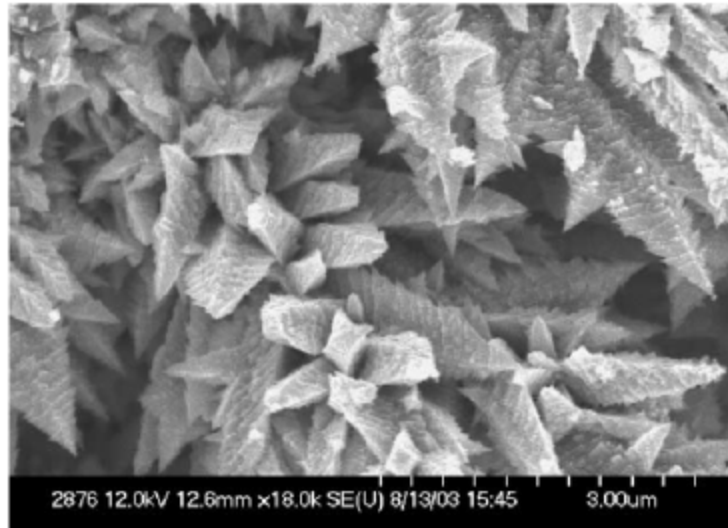
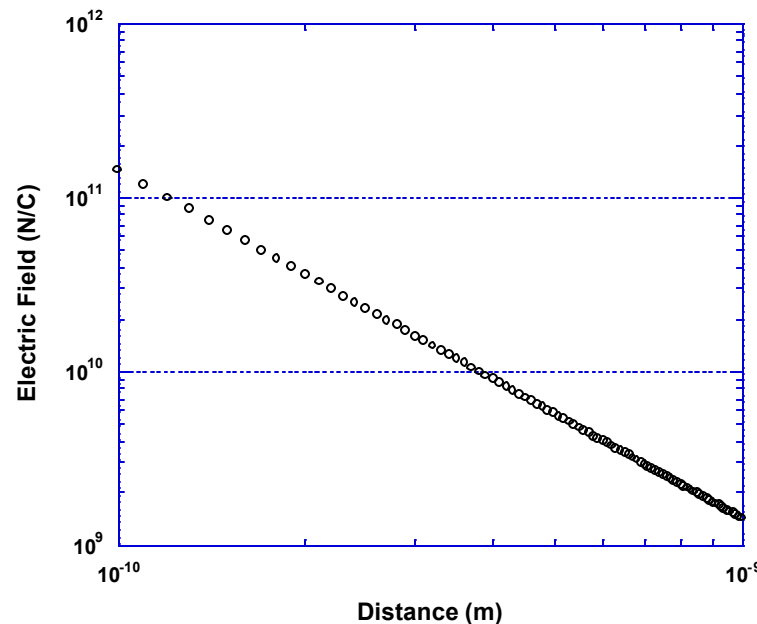


Fig. 6. Dendritic growth due to the action of the cell current on microglobules immobilized in tight pores

S. Szpak et al. / Journal of Electroanalytical Chemistry 580 (2005), p 288

Estimate of Electric Field due to Cation and Electron



Simple approximation of the electric field (E) indicating that $E > 10^9$ N/C (multiple angstrom separation distance) is probably necessary for altering the electron's charge state

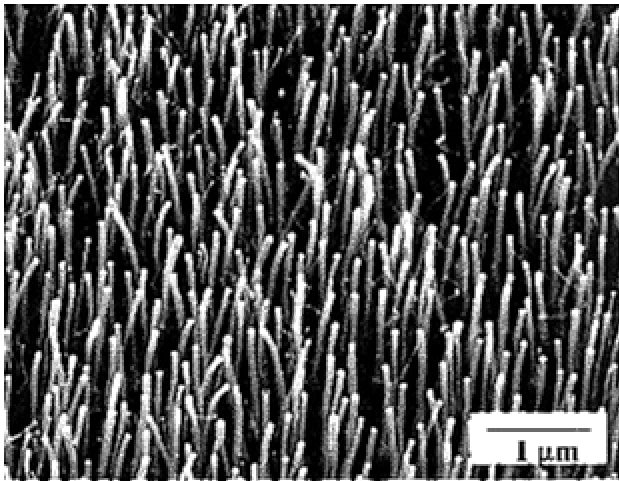
Creating Microstructured Cathodes

Possible Materials Ideas

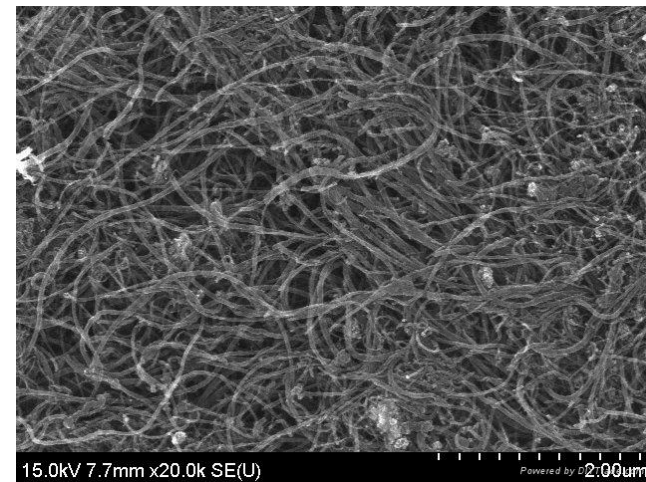
- **Carbon Nanotubes** (use ideas being developed for battery technology)
- **Graphene Sheets** (new formation technology being developed)
- **Black Silicon** (Mazur Group, Harvard)

Possible Cathode Surface Materials

Carbon Nanotubes



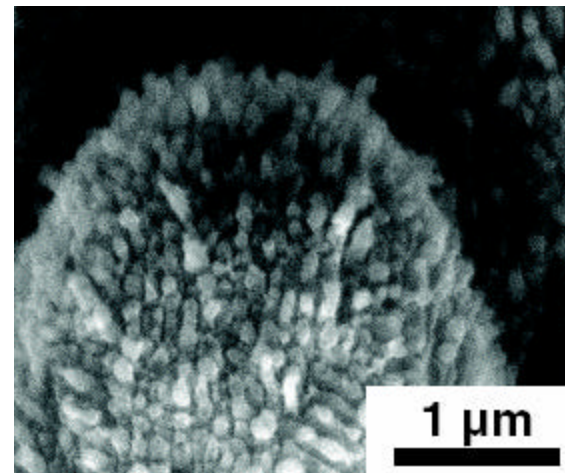
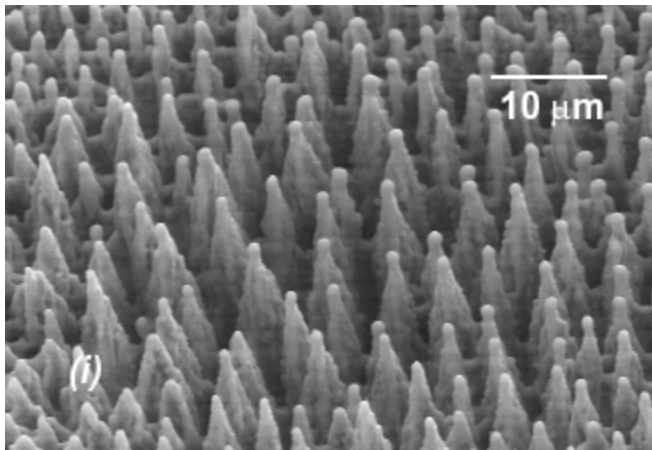
Parallel Carbon Nanotubes



Entangled Carbon Nanotubes

Possible Cathode Surface Materials

Black Silicon



Mazur Group, Harvard University

Proposed Conditions To Alter the Charge State of the Electron

- Constrain the electron's motion in the cathode (allows sufficient time for applied force to cause charge state change)
 - Possible geometries: 2-dimensional graphene sheets, carbon nanotubes, processes like black silicon (Mazur Group, Harvard) and other similar surface morphologies
- Create an electric field of sufficient strength to flip the charge state by proximity to cation in electrolyte (liquid, gel, or solid)
 - Simple estimate of 10^9 to 10^{10} Newtons/Coulomb

Summary

- **Discovery of the positive electron (1932)**
 - Alternate implication is that the charge state of the electron may be able to be changed (a new electron behavior to exploit)
- **Charge State Change -- Under What Conditions?**
 - Hints possibly from FQHE, High T_c Superconductivity, and electrochemically generated excess energy
 - Best estimate for a practical positron source is possibly given by electrochemically generated excess heat
 - Cathode with surface morphology to constrain the electron's motion
 - Can vary the applied voltage to the electrochemical cell to control the annihilation reaction based on temperature and the intensity of gamma rays produced
- **The annihilation reaction would be the **UTIMATE GREEN ENERGY SOURCE****
 - Considering the incredible energy implications, it should be worth the small cost to investigate the validity of this proposed new property of the electron

APPENDIX

Neutral Electron?

- Many particles discovered have been seen to exist in three charge states
 - negative, neutral & positive
- **Is there a neutral electron?**
 - Could this be the neutrino?
 - Pauli wrote in his famous 1930 letter “The mass of the neutron [neutrino] must be of the same order of magnitude as the electron ...”
 - Present estimates put the mass much less than that of the electron – This raises the intriguing question

Is there energy (mass) associated with charge?