

# Fingerprints Forever

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# Fingerprints forever



Visualizing fingerprints in the corrosion that sweat causes to metals

# Fingerprints forever

How do fingerprints  
solve crime?

# Fingerprints forever



“As he held the match nearer I saw it was the well marked print of a thumb”



“You are aware that no two thumb marks are alike”



# What are fingerprints



Arch



Tented Arch



Loop



Whorl

Fingerprint patterns

# What are fingerprints



Arch



Tented Arch



Loop



Whorl

Central pocket



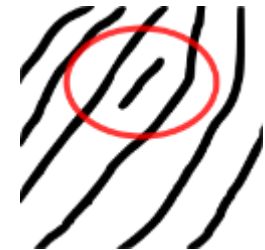
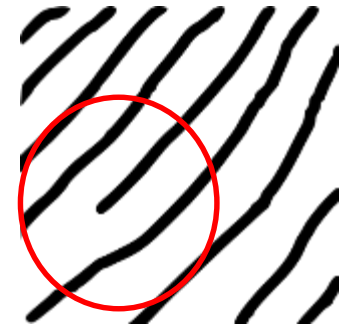
Fingerprint patterns



Double loop

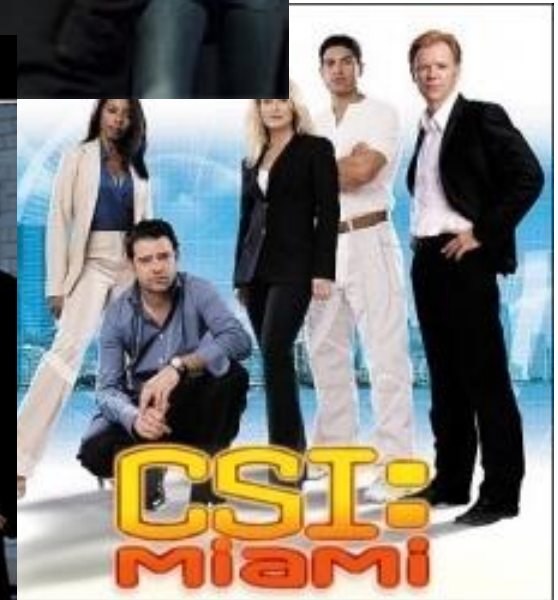
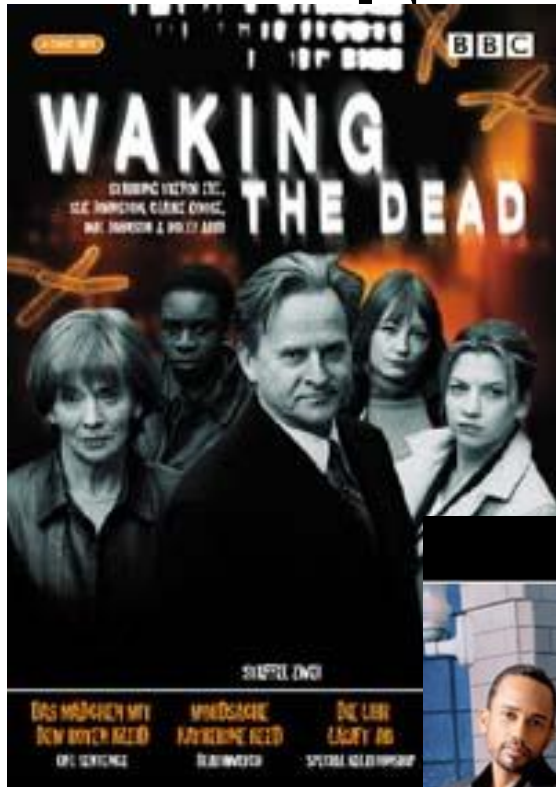
# Ridge Features

- *Ridge ending* – the abrupt end of a ridge
- *Ridge bifurcation* – a single ridge that divides into two ridges
- *Short ridge, or independent ridge* – a ridge that commences, travels a short distance and then ends





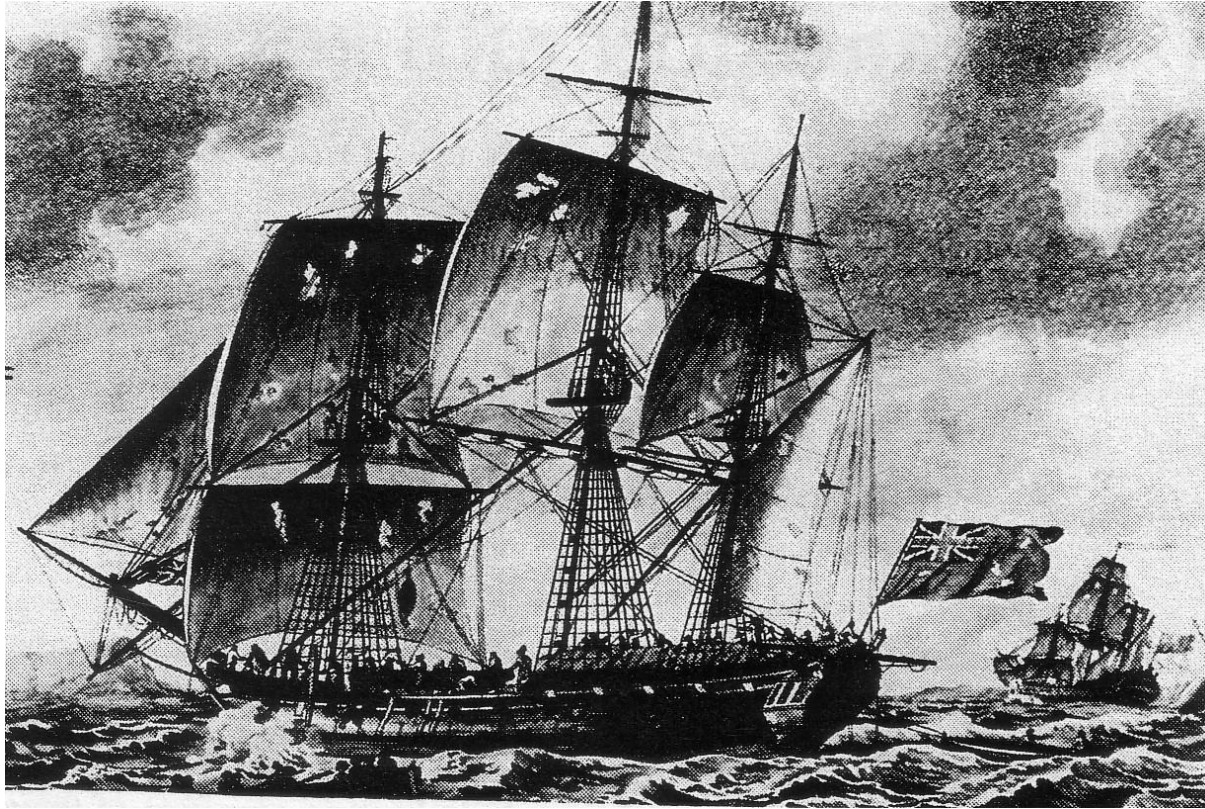
# Fingerprints Forever



Fingerprints forever

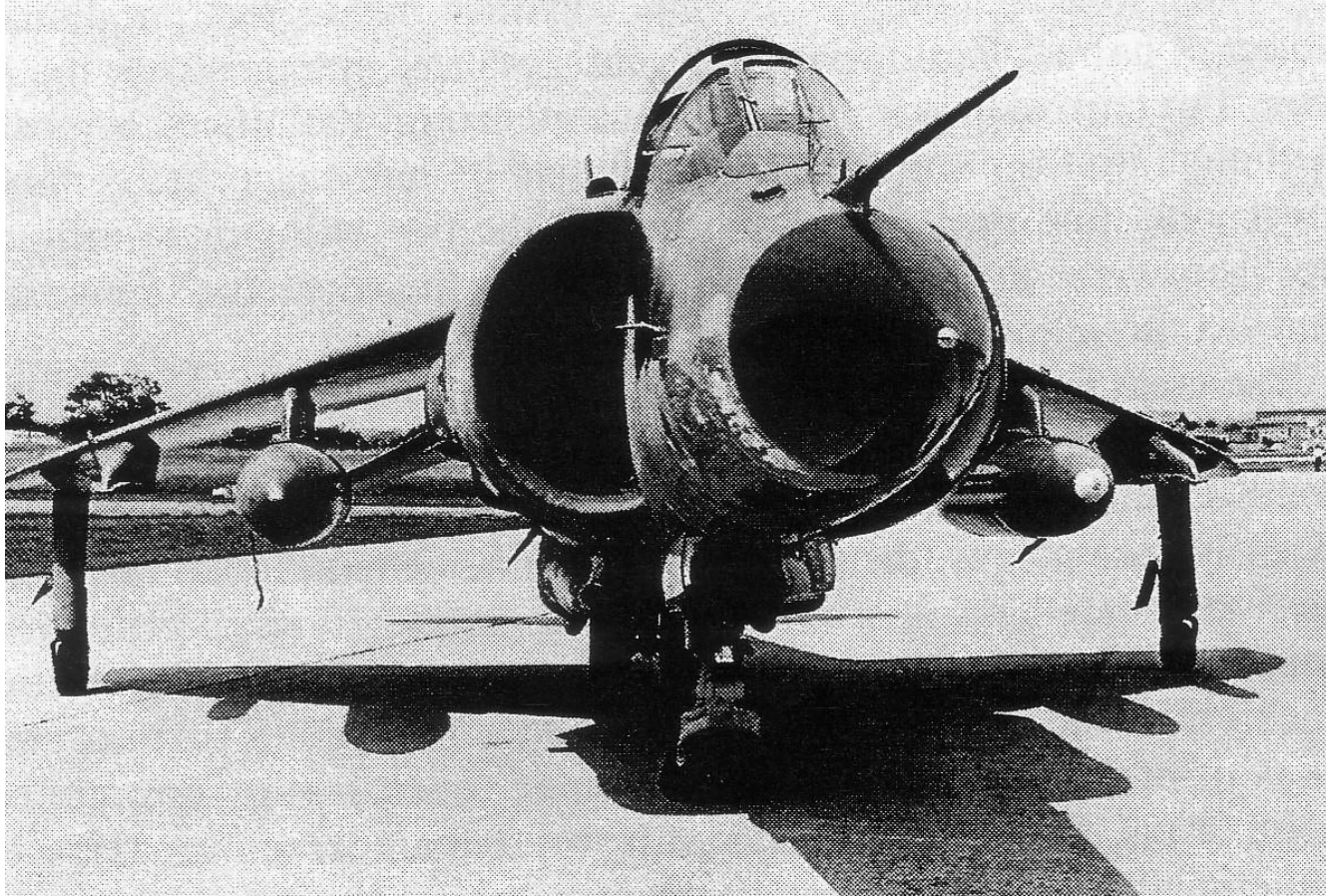
What is metal corrosion?

# Fingerprints Forever



HMS Alarm, subject of the first recorded study  
of bimetallic corrosion, 1763

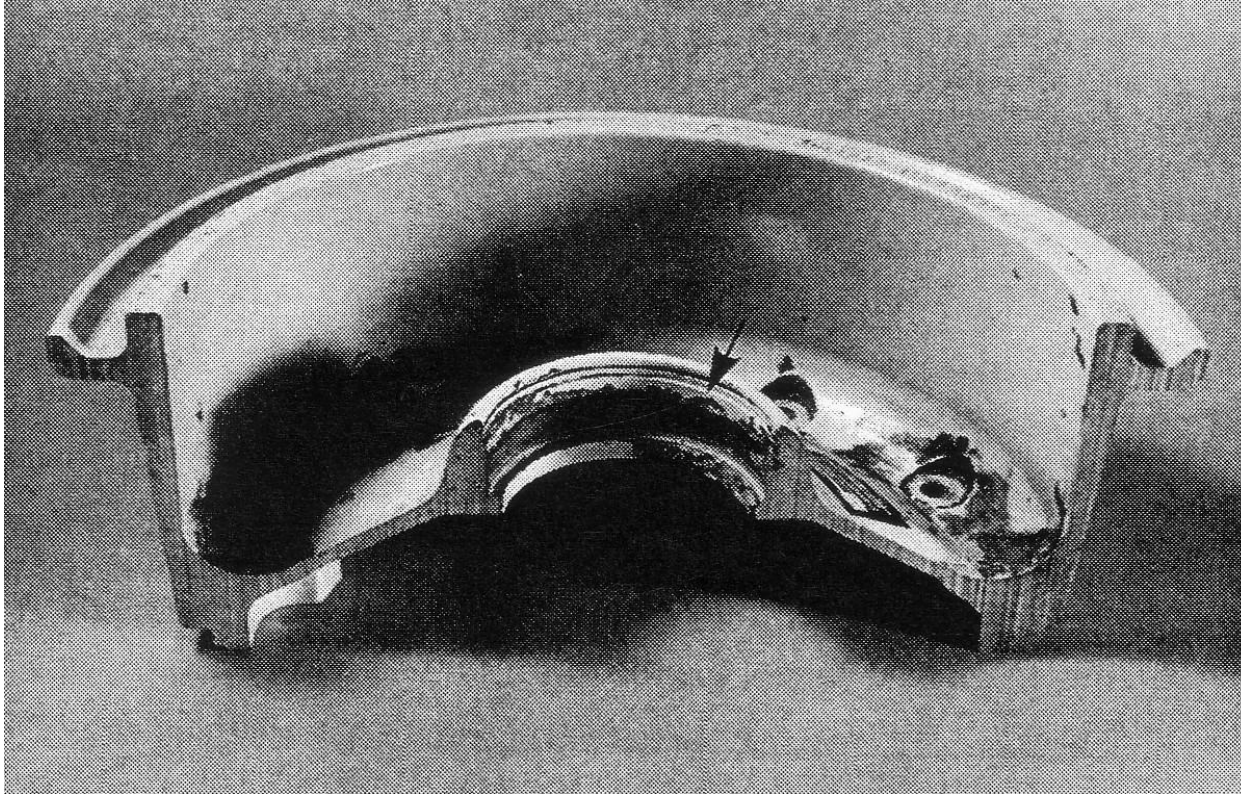
# Fingerprints Forever



Royal Navy Sea Harrier

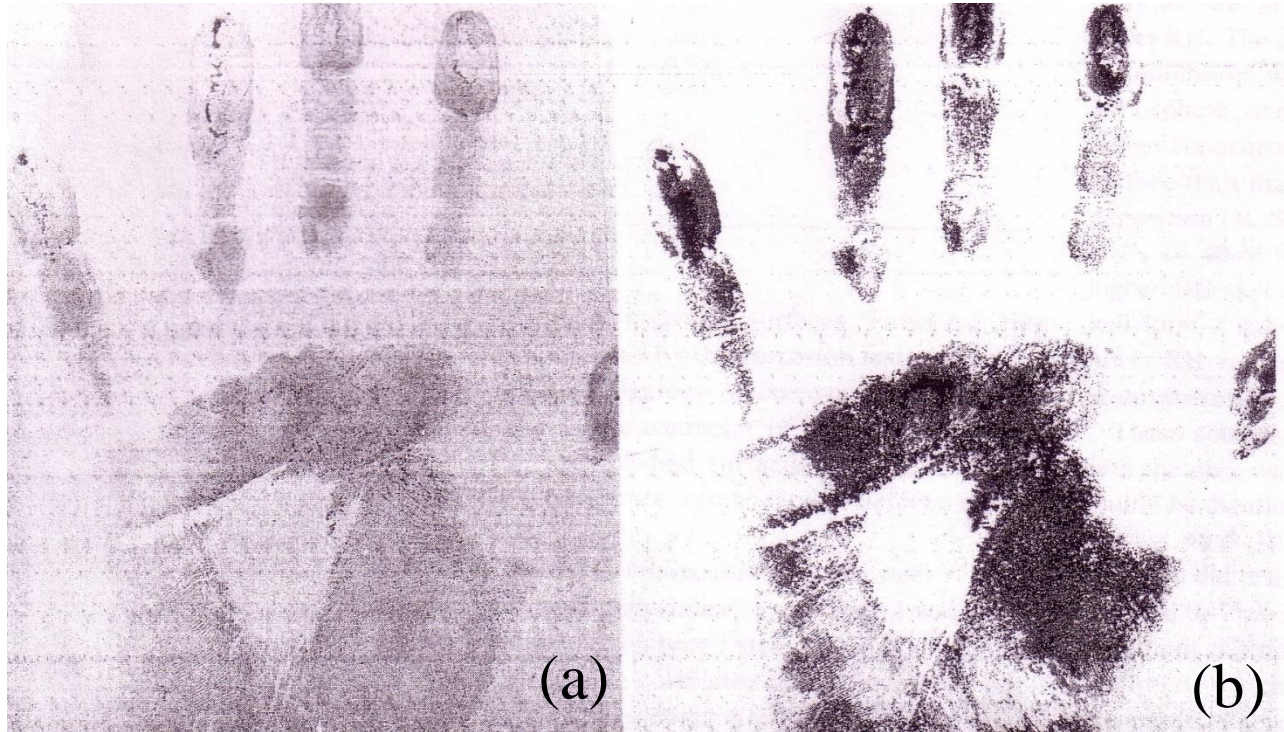


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Cross section of failed wheel of Sea Harrier caused by bimetallic corrosion of magnesium alloy and steel, 1982.

# Fingerprints Forever

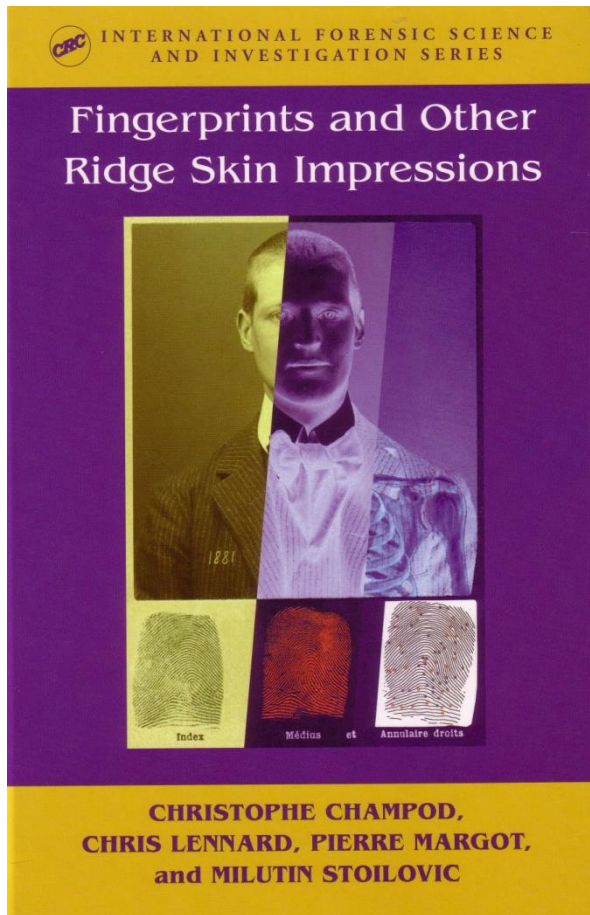


Hand print on mild steel (a) 2 weeks, (b) 2 months after deposition.  
High salt = high corrosion in 'rusters' (hyperhidrosis)

*Jensen Acta Dermatovener 1979*



# Fingerprints Forever



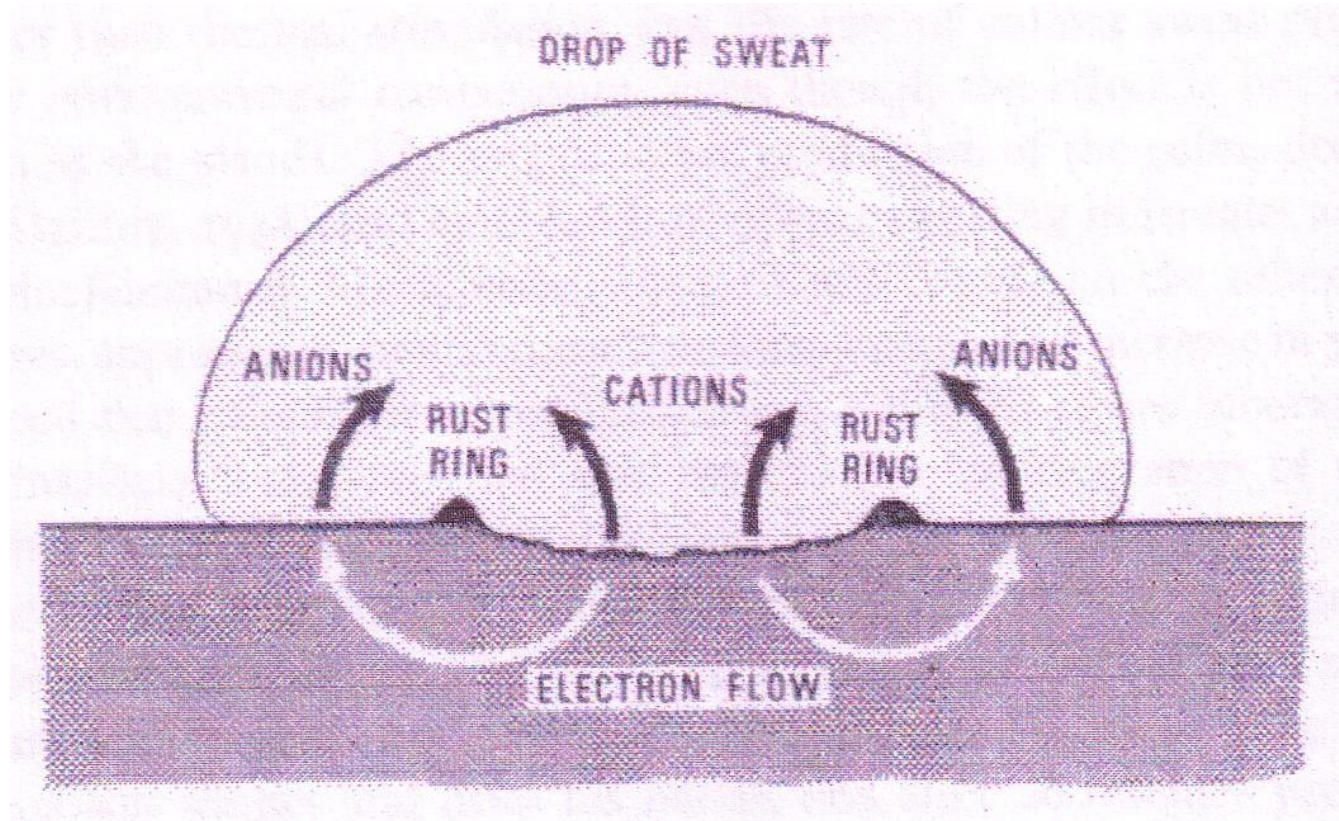
“...latent finger marks on brass cartridge cases may sometimes spontaneously develop over time.....”

Champod et al. *Fingerprints and other ridge skin impressions* 2004

# Fingerprints Forever

Why does salt water  
(or fingerprint sweat with salt in it)  
corrode metal?

# Fingerprints Forever



Corrosion of iron by a drop of sweat

Burton et al. *Br J Dermatol* 1976 (after Evans *An introduction to metal corrosion* 1963)

# Fingerprints Forever

Where does this electrical current come from?

# Fingerprints Forever

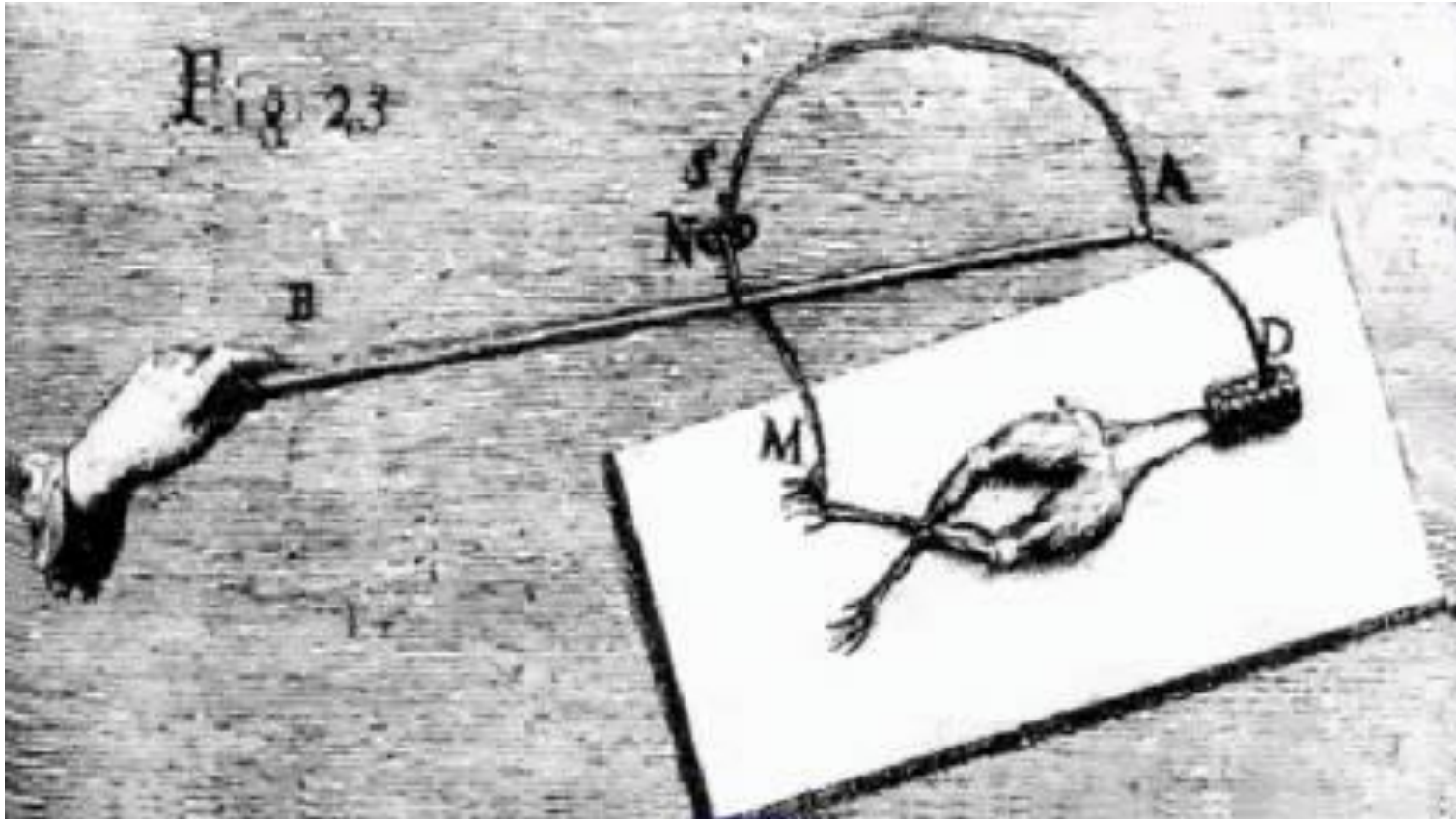


Luigi Galvani, 1737 – 1798

In 1786, whilst dissecting a frog, Galvani's assistant touched an exposed sciatic nerve of the frog with a metal scalpel, which had picked up an electrical charge. They saw sparks and the dead frog's leg kicked as if it were alive.



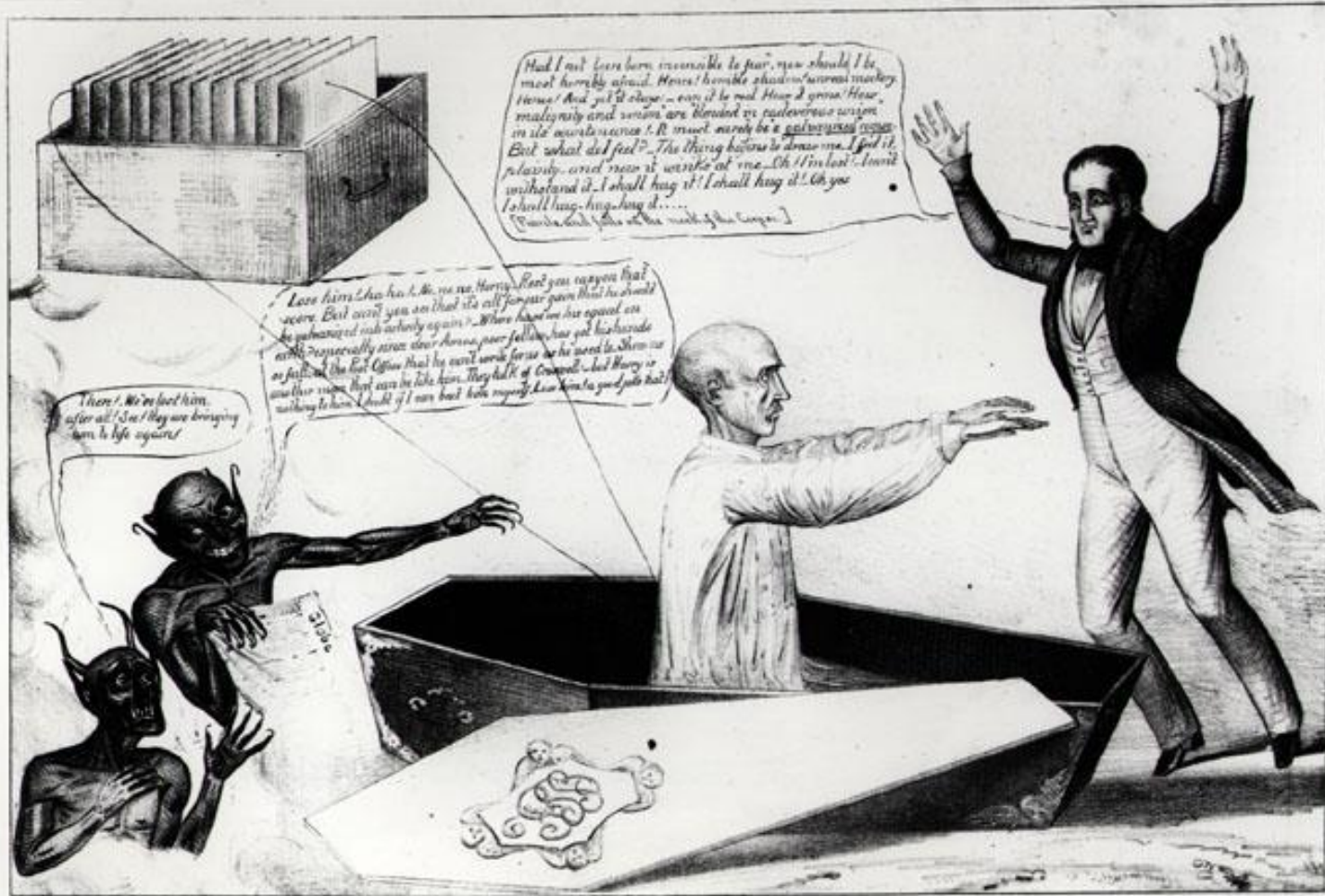
# Fingerprints Forever



Galvani called this *animal electricity*.



# Fingerprints Forever



A GALVANISED CORPSE

Printed & Pub. by H. R. Johnson, No. 21 Courtland St. N. Y. & Penna. America, Washington D. C.

REPRODUCED FROM THE ORIGINAL

# Fingerprints Forever

1084. The most striking effects of Galvanism on the human frame, after death, were exhibited at Glasgow, a few years ago. The subject on which the experiments were made was the body of the murderer Clydesdale, who was hanged at that city. He had been suspended an hour, and the first experiment was made in about ten minutes after he was cut down. The galvanic battery employed consisted of 270 pairs of four-inch plates. On the application of the battery to different parts of the body, every muscle was thrown into violent agitation; the leg was thrown out with great violence, breathing commenced, the face exhibited extraordinary grimaces, and the finger seemed to point out the spectators. Many persons were obliged to leave the room from terror or sickness; one gentleman fainted, and some thought that the body had really come to life.

*Natural and Experimental Philosophy, 1854*

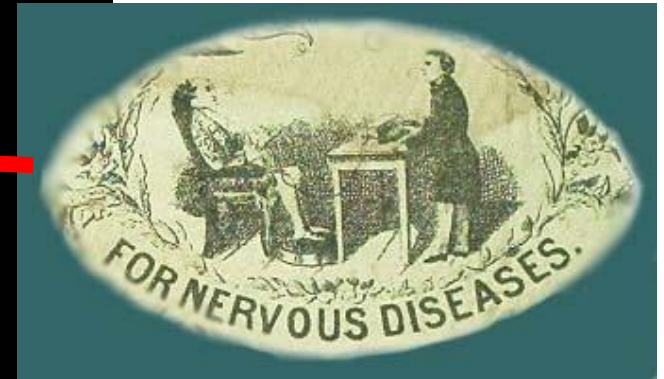
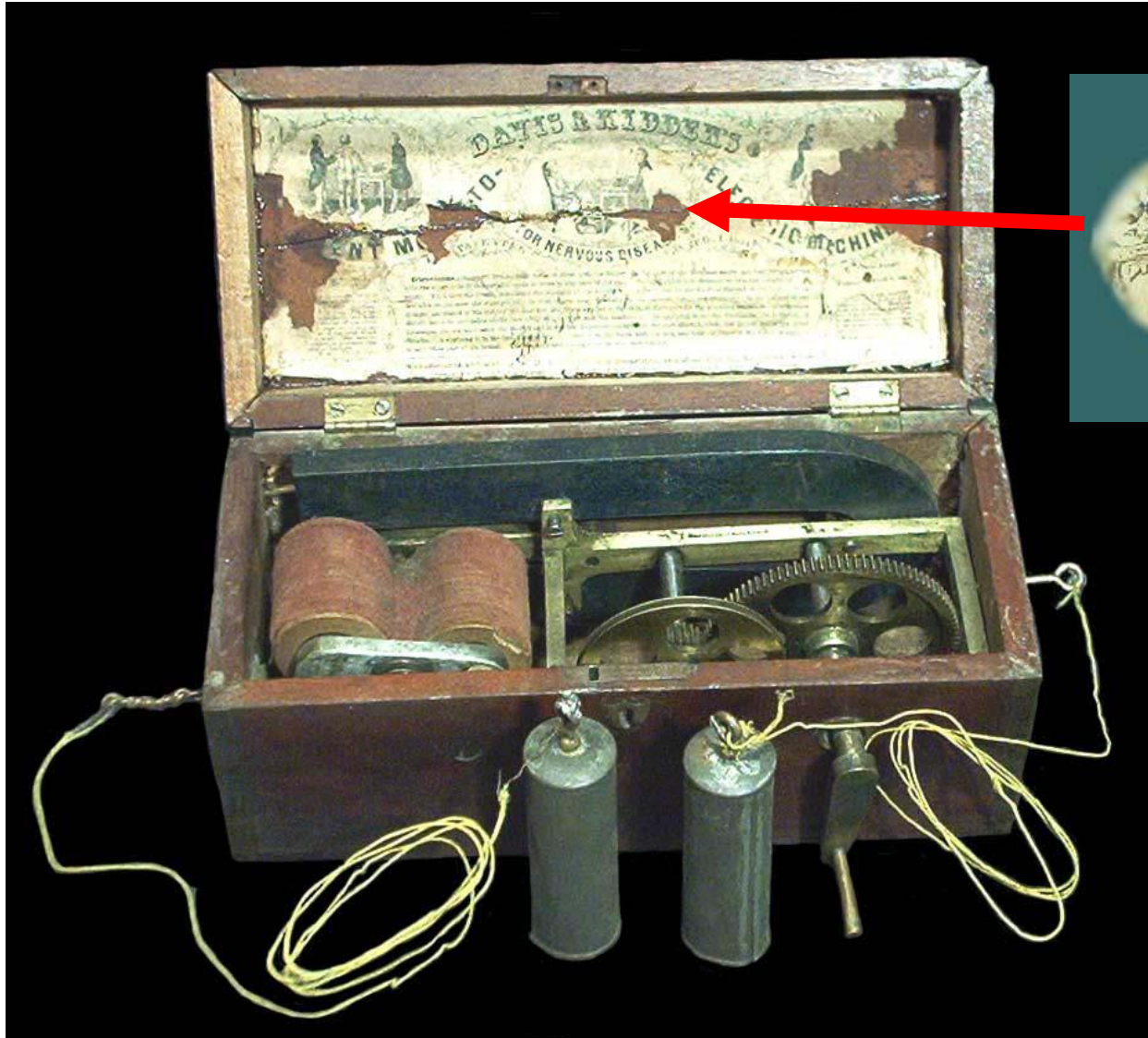


# Fingerprints Forever



“I saw the hideous phantasm of a man stretched out, and then, on the working of some powerful engine, show signs of life, and stir with an uneasy, half vital motion“.

# Fingerprints Forever





# Fingerprints Forever

Rejuvenate your complexion, revitalize your scalp,  
and refine your body.



- Introducing Nu Skin Galvanic Spa™ II system:
- Programmable device with patented self-adjusting Galvanic currents and interchangeable heads for the face, scalp and body.
- Works synergistically with specially formulated products to facilitate transport of key ingredients delivering revitalizing, restorative and rejuvenating benefits.



# Fingerprints Forever





# Fingerprints Forever

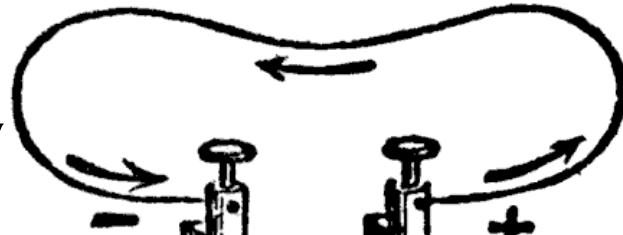
A contemporary of Galvani, Alessandro Volta, reasoned that animal electricity was a physical phenomenon.

Volta coined the term *galvanism* when an electrical current is produced by chemical action.

Volta built the first battery or “Voltaic Cell”

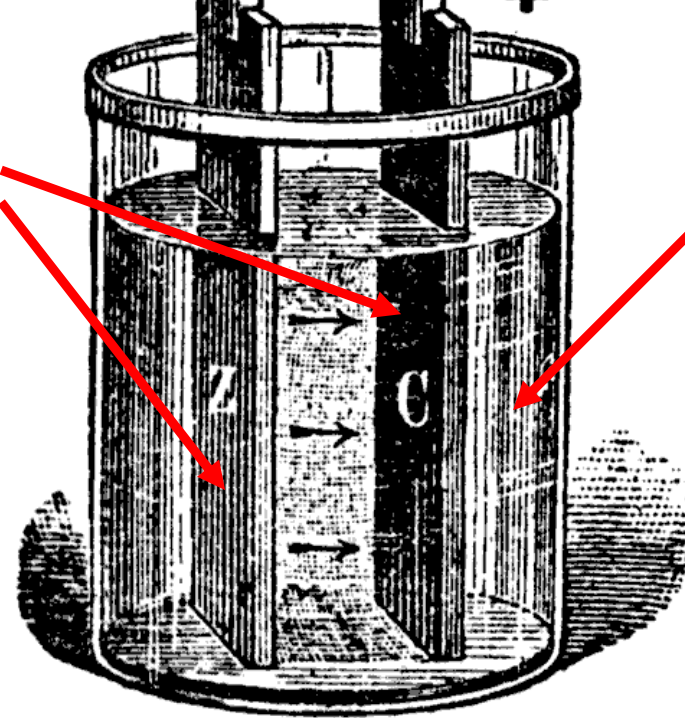
# Fingerprints Forever

Connecting electrodes  
Causes current to flow



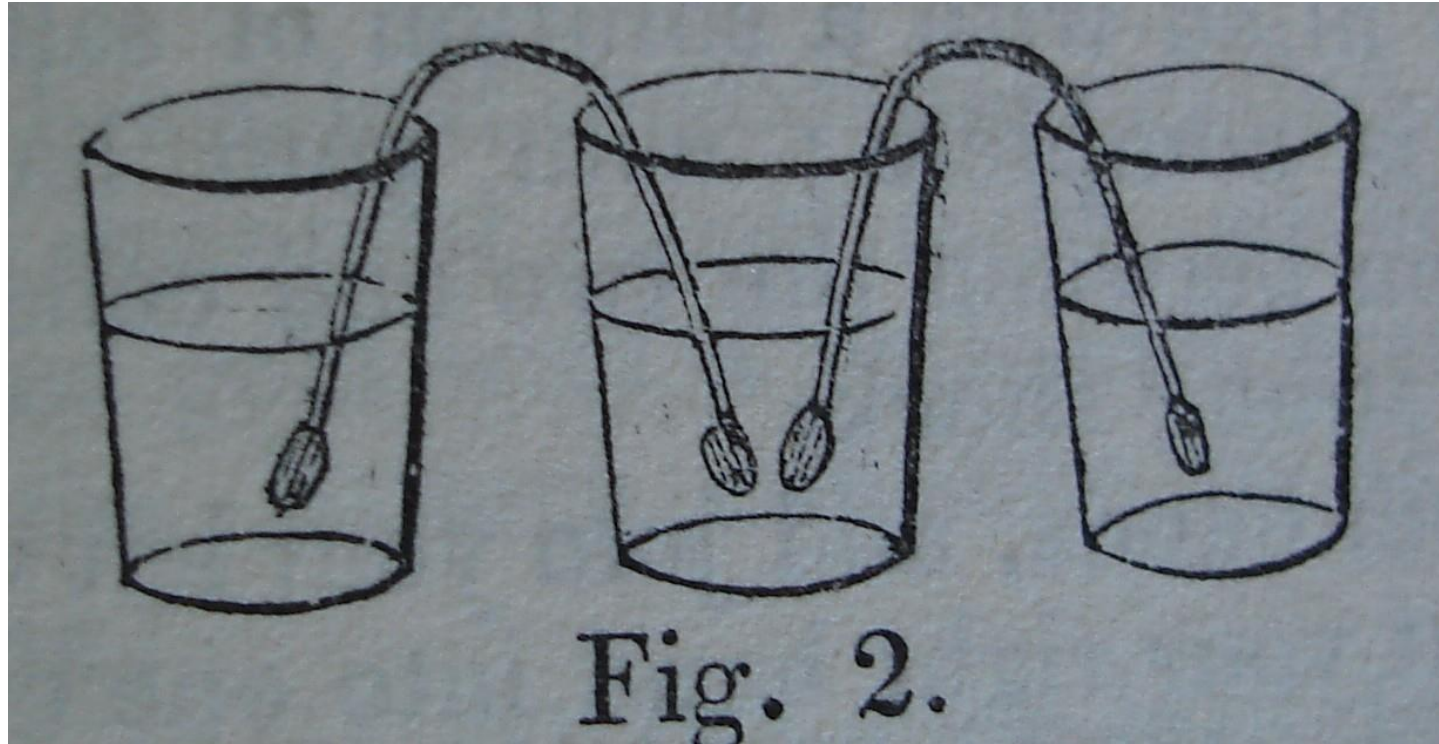
Dissimilar metals  
(e.g. copper and zinc  
= electrodes)

Conducting liquid  
(e.g. salt solution  
= electrolyte)



An early voltaic cell

# Fingerprints Forever



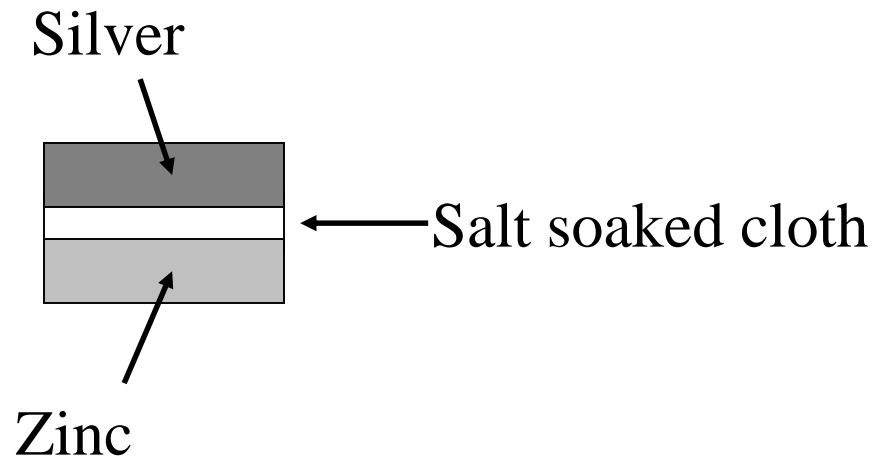
A home made voltaic cell, silver and zinc in solutions of salt water  
*Scientific Dialogues*, 1836

“Dip one hand into the first glass, and the other into the last”

# Fingerprints Forever



A voltaic pile



# Fingerprints Forever

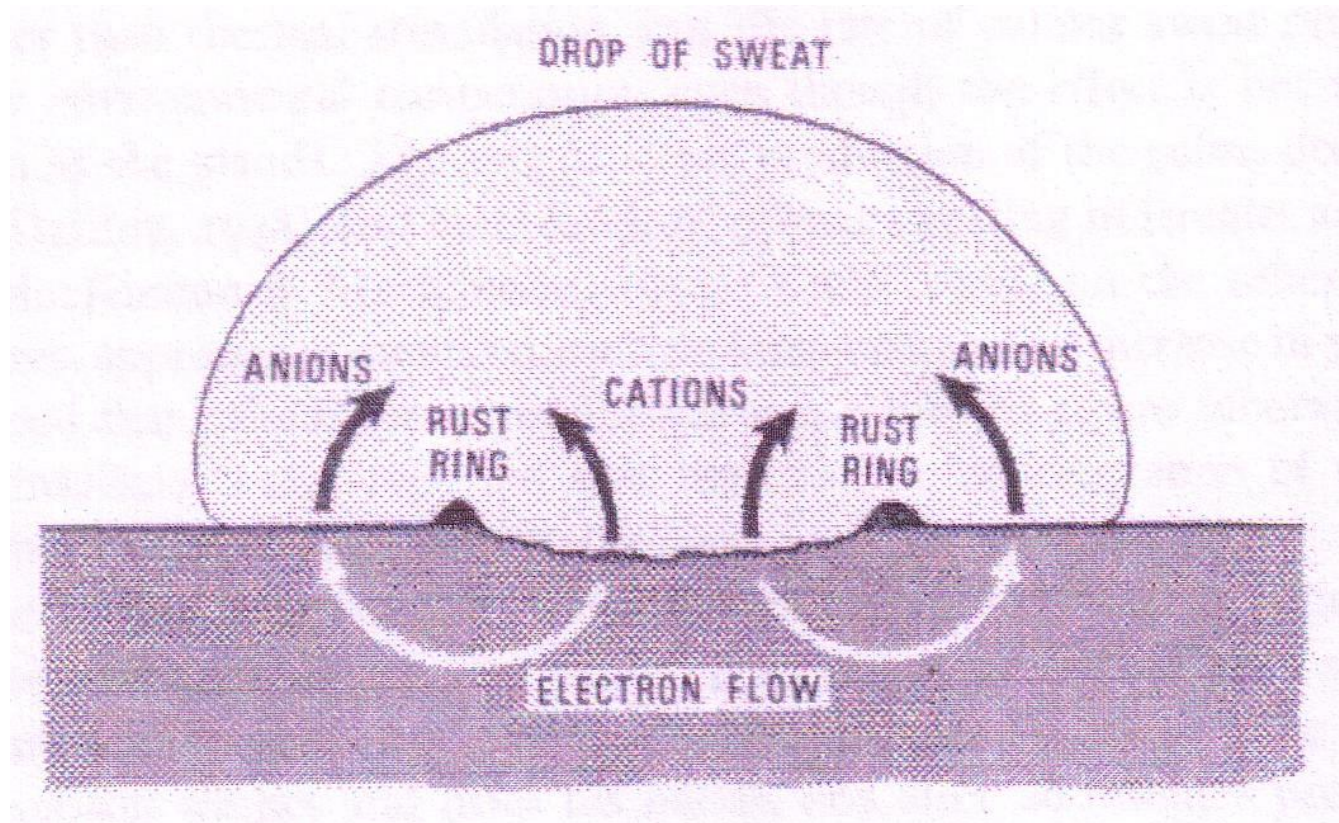




# Fingerprints Forever

How does this work with fingerprint sweat?

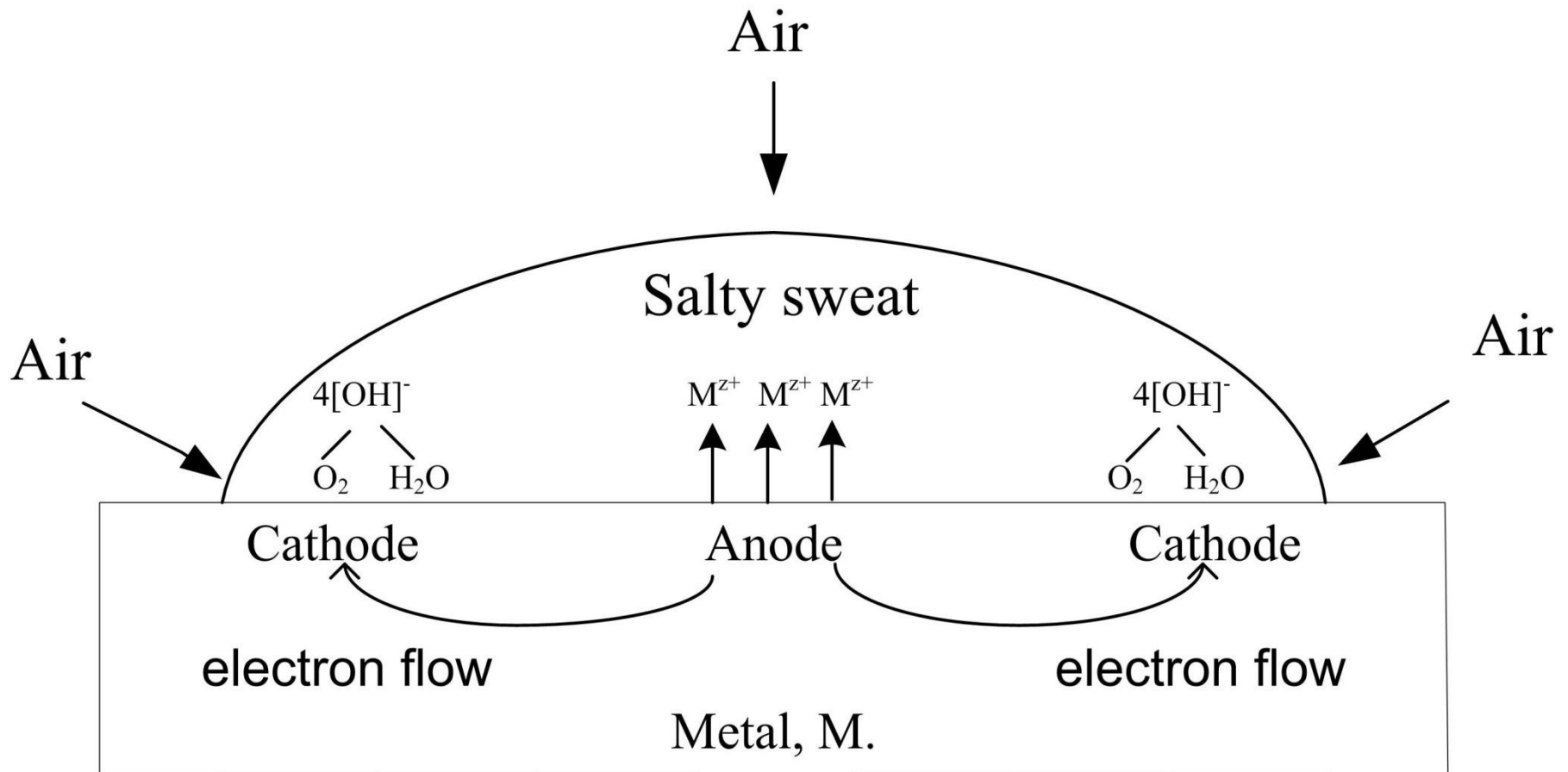
# Fingerprints Forever

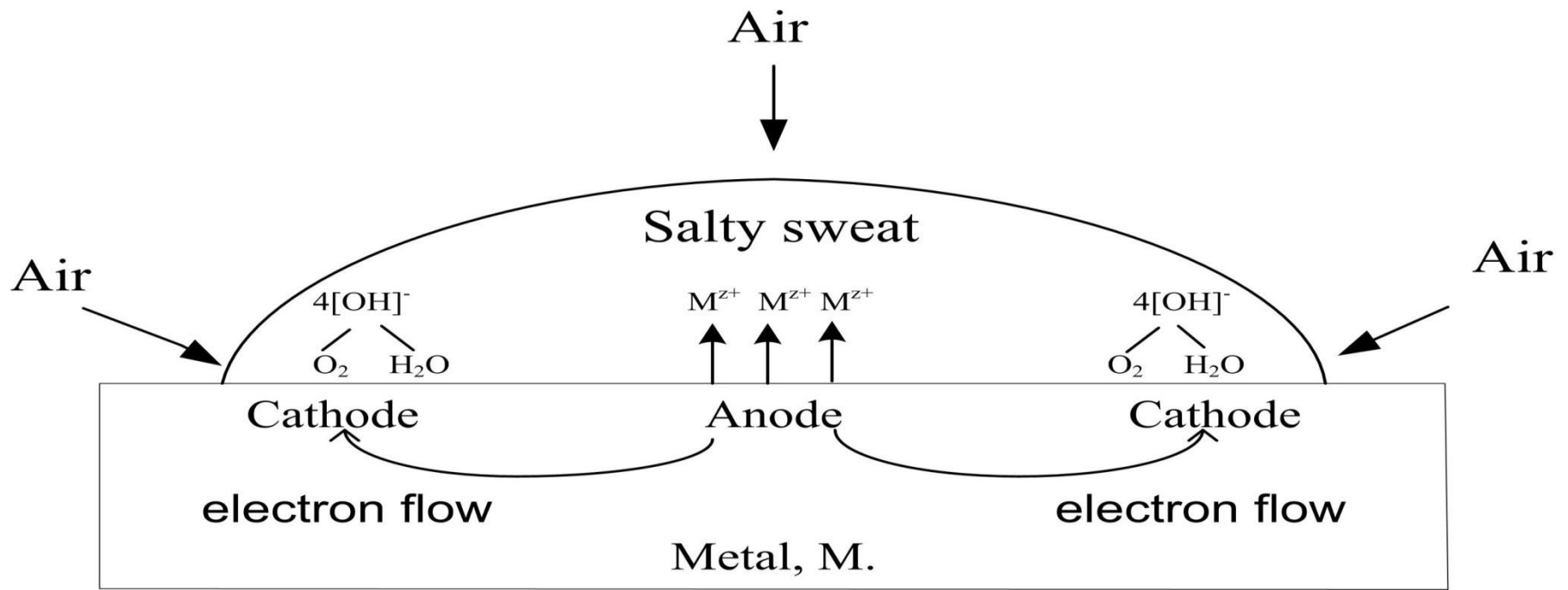


Corrosion of iron by a drop of sweat

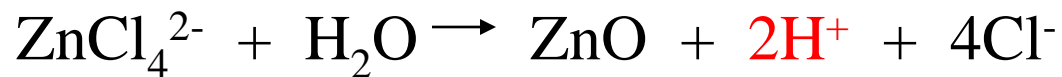
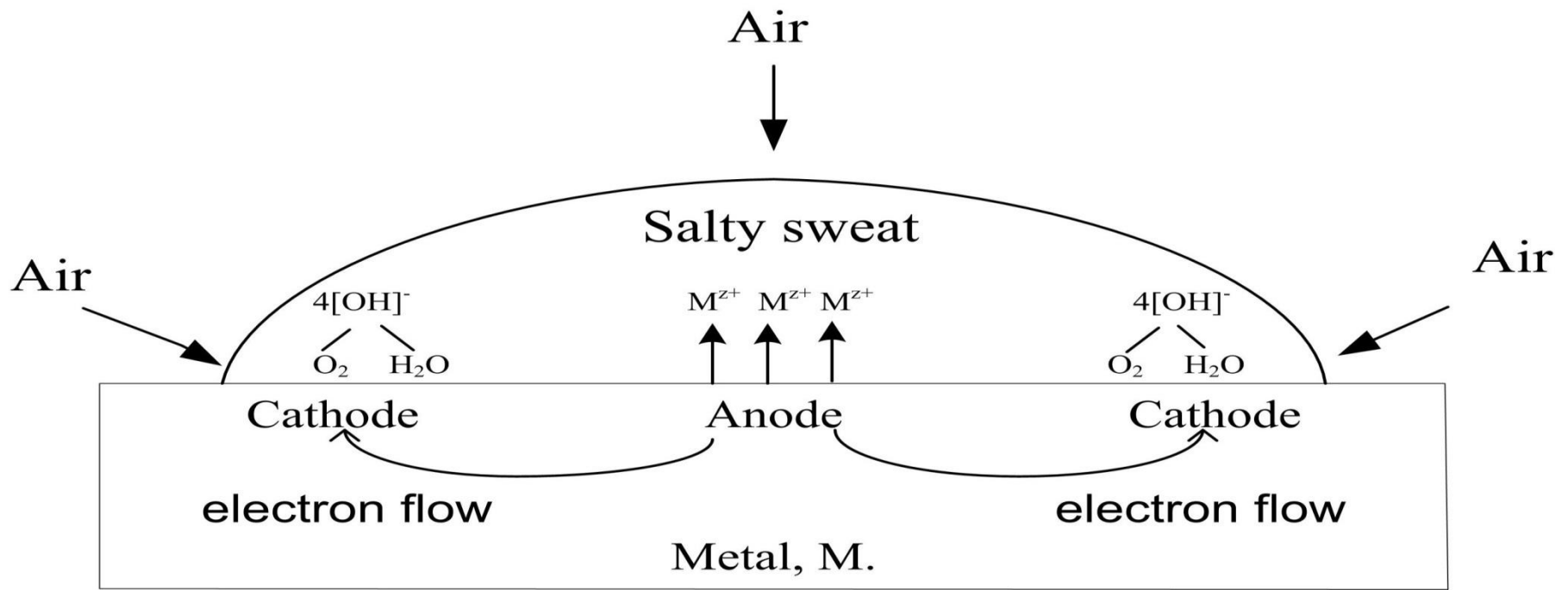
Burton et al. *Br J Dermatol* 1976 (after Evans *An introduction to metal corrosion* 1963)

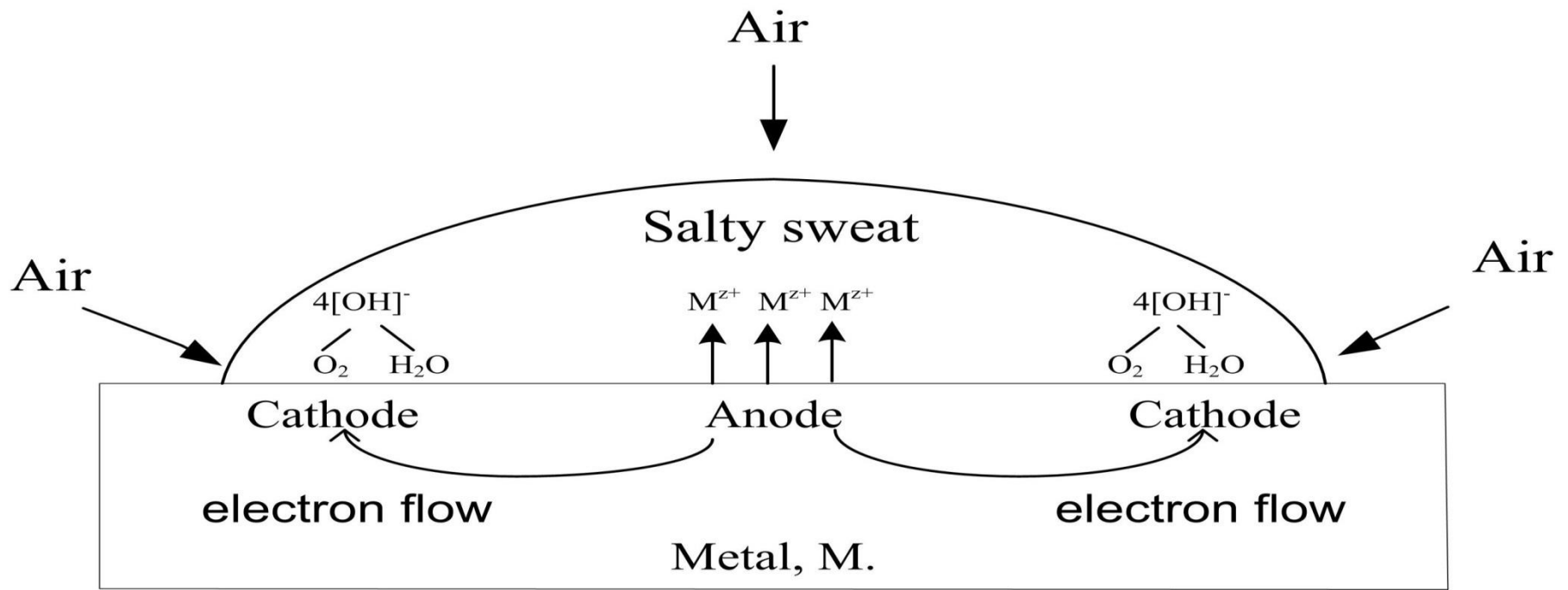
# Fingerprints Forever



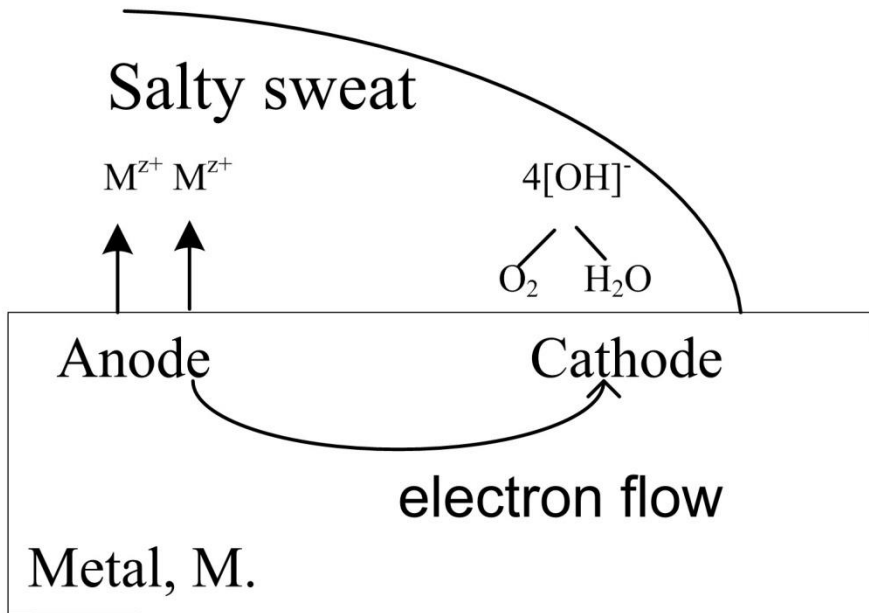




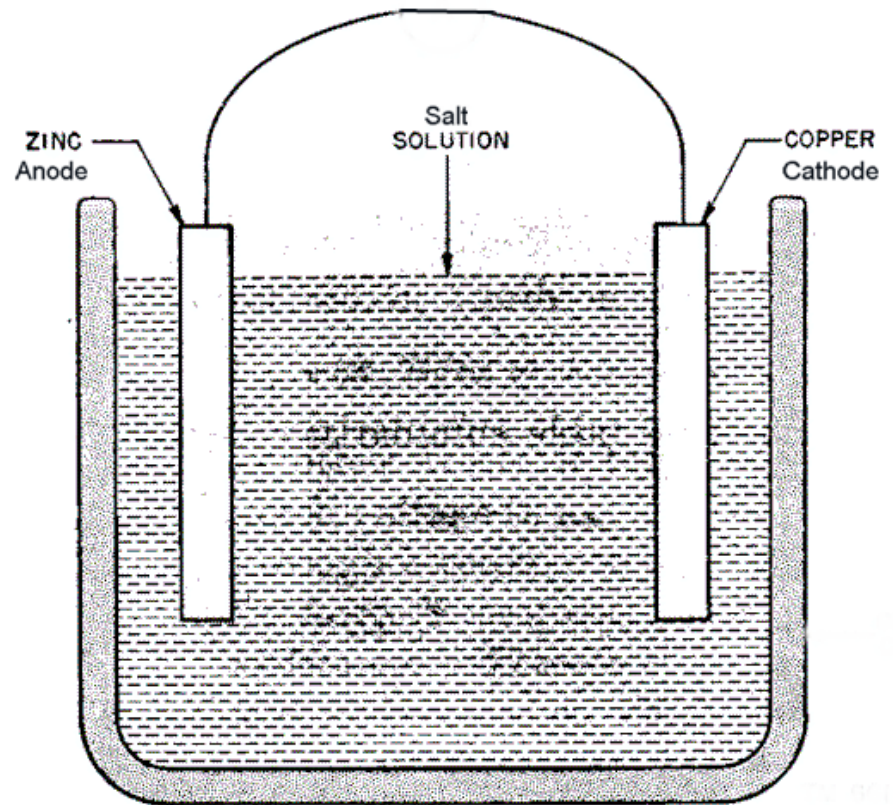
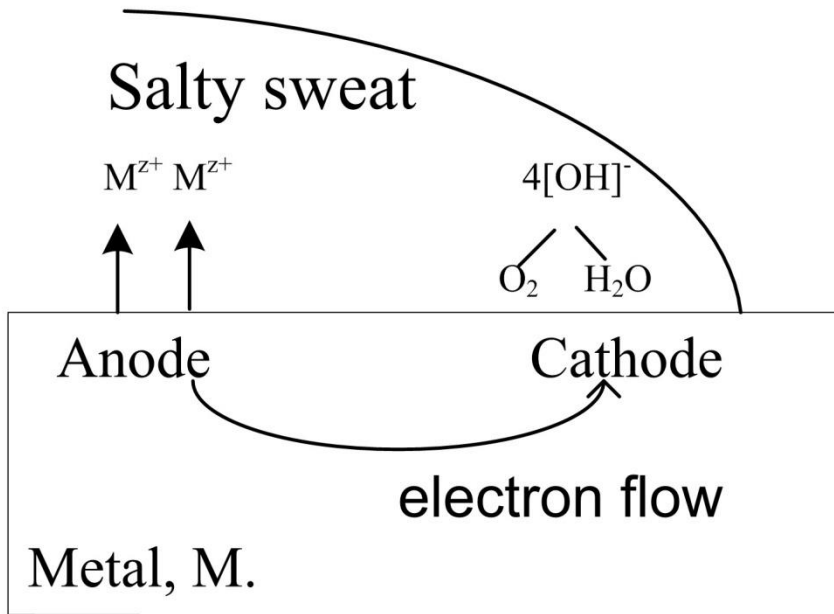




# Fingerprints Forever

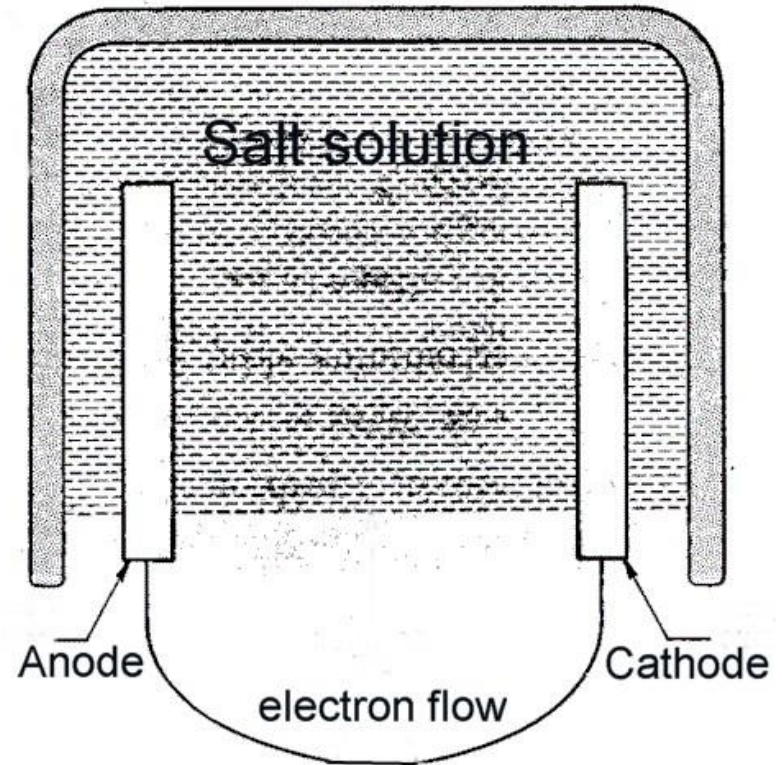
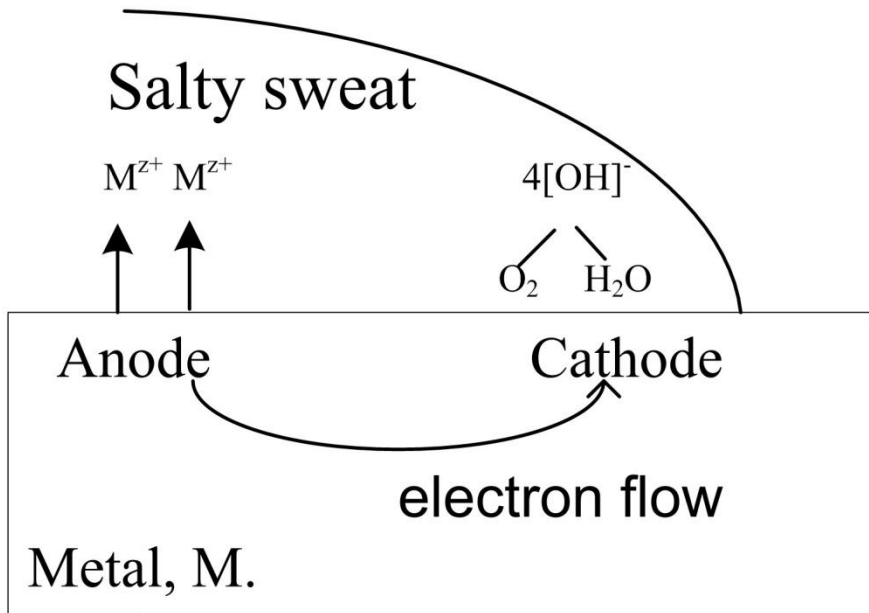


# Fingerprints Forever

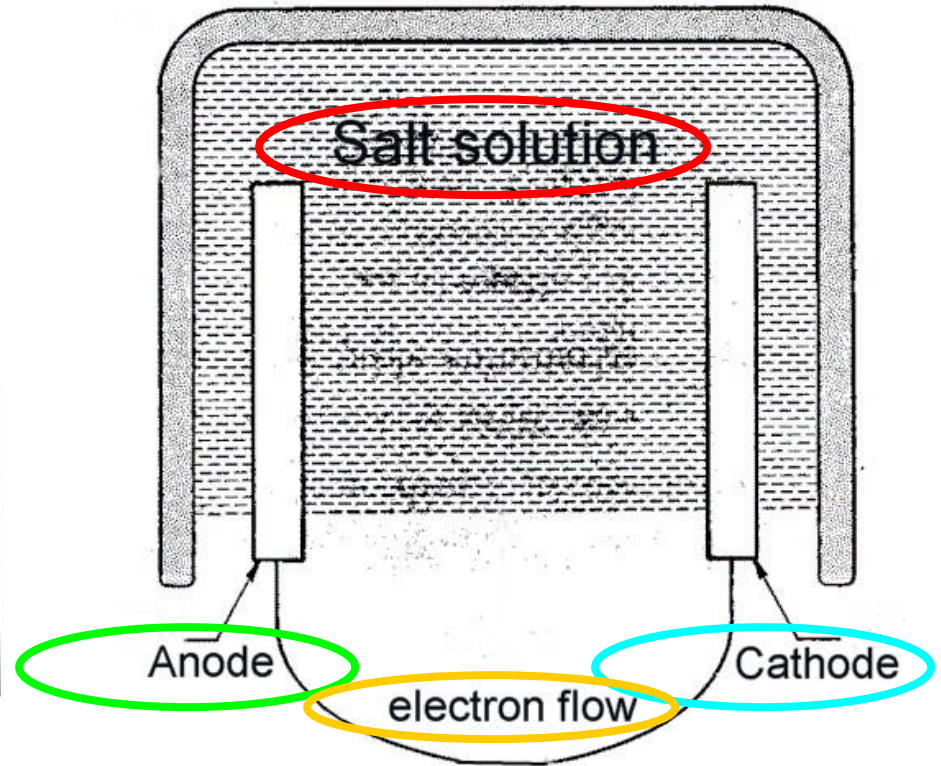
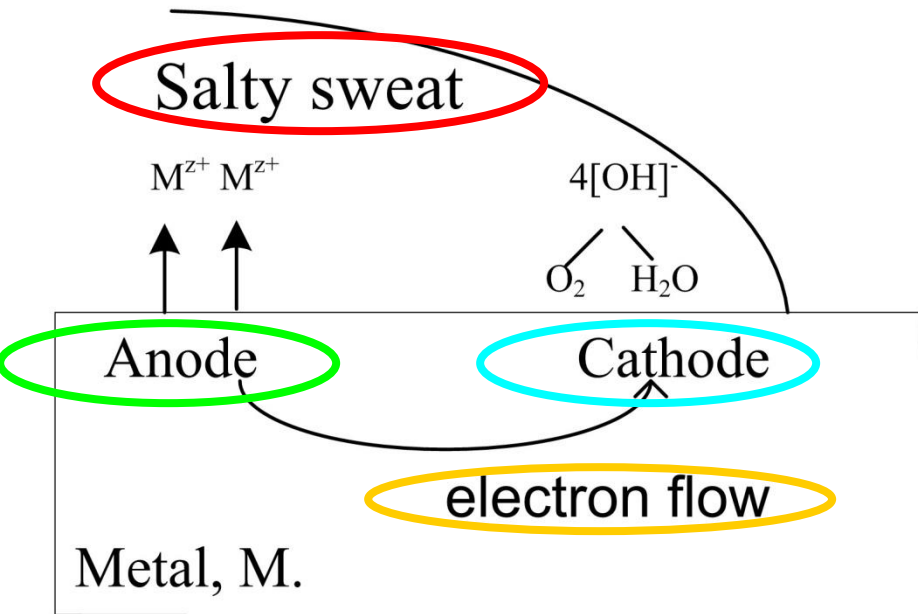




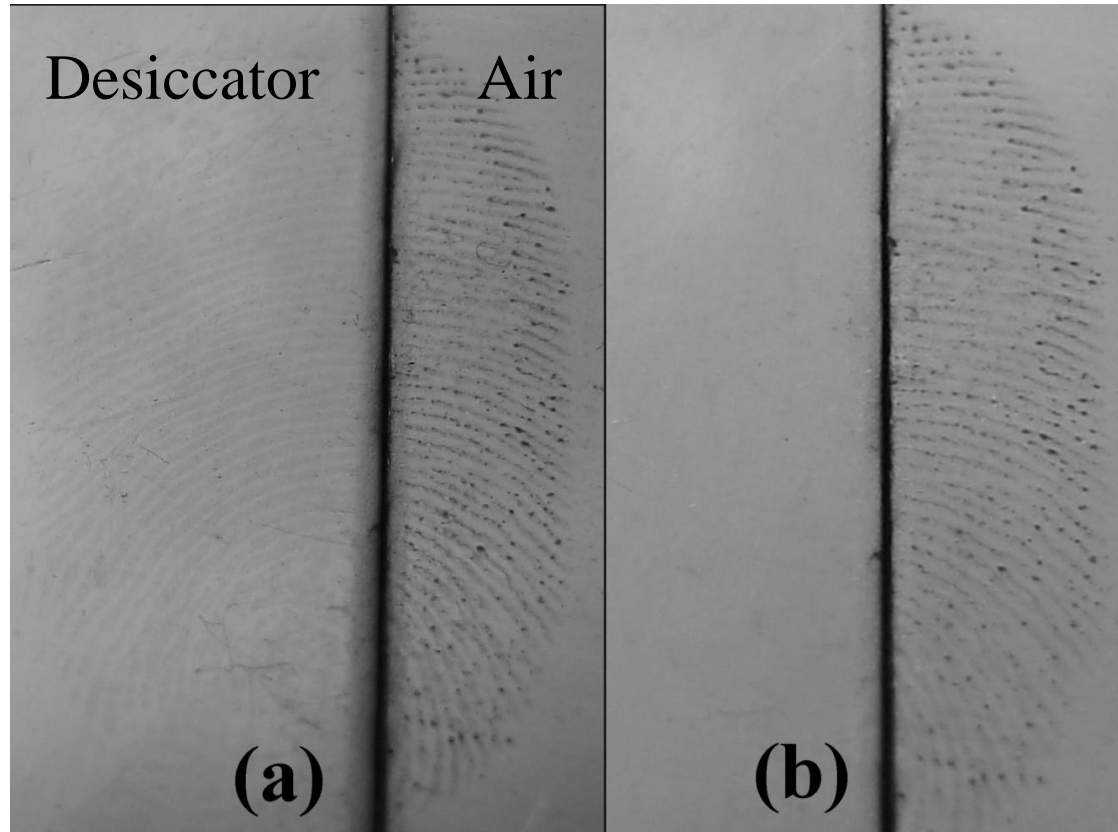
# Fingerprints Forever



# Fingerprints Forever



# Fingerprints Forever



Brass 10 days after deposition. (b) = (a) after washing

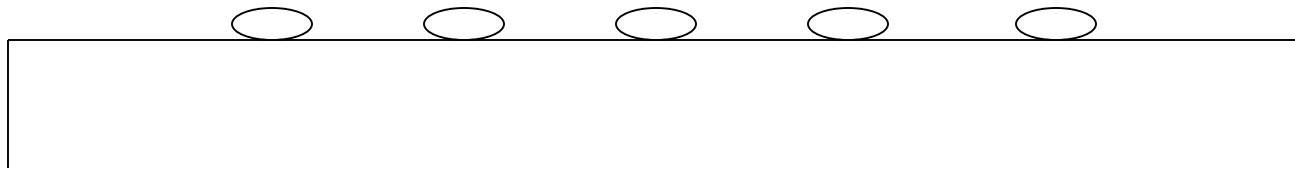
# Fingerprints Forever

How do we see this corrosion?

and

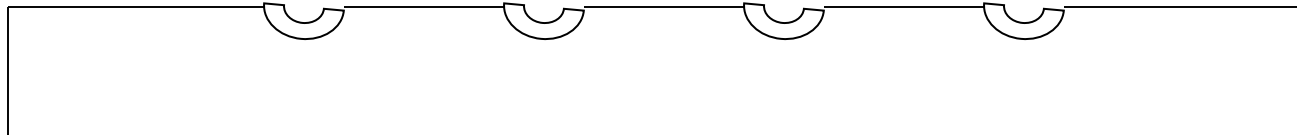
Can this be used on real crimes?

# Fingerprints Forever



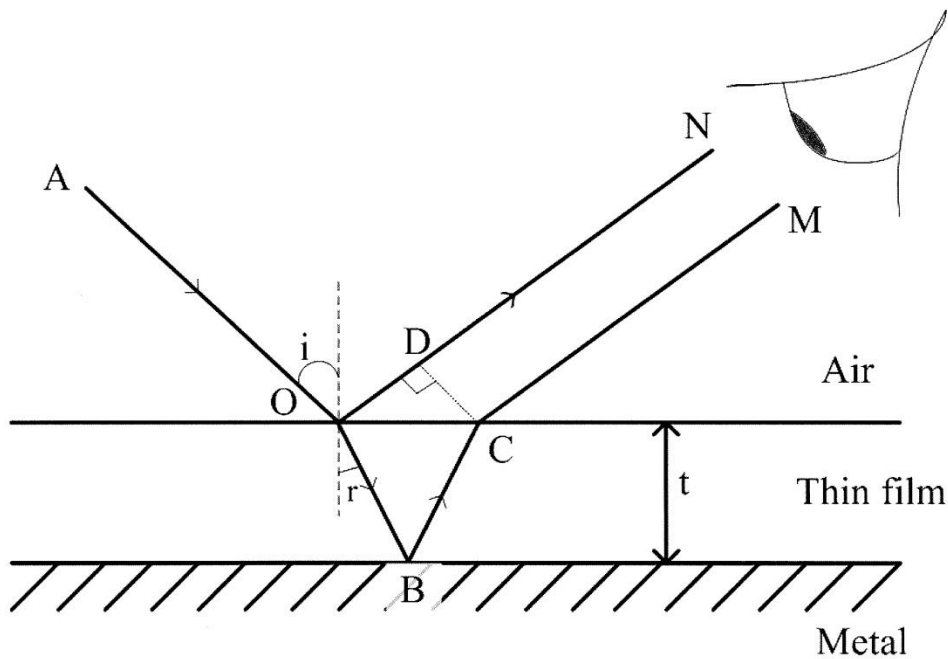


# Fingerprints Forever



# Fingerprints Forever

Method 1 : Look at it (optical interference)



Constructive interference when

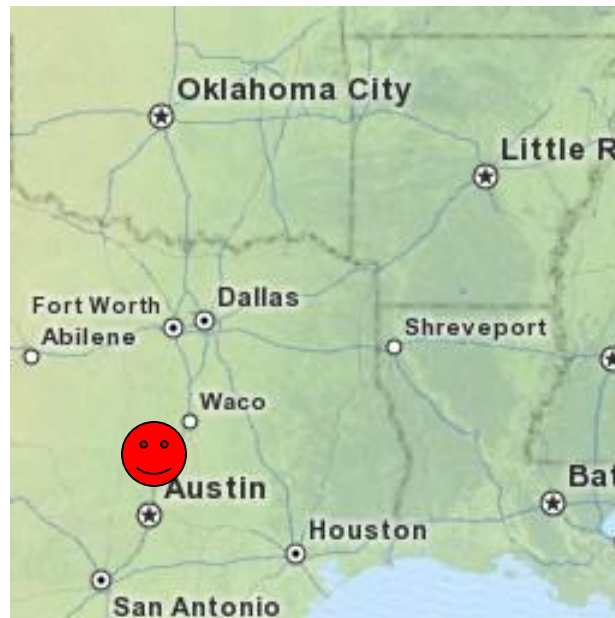
$$2nt\cos r = m\lambda$$

# Fingerprints Forever



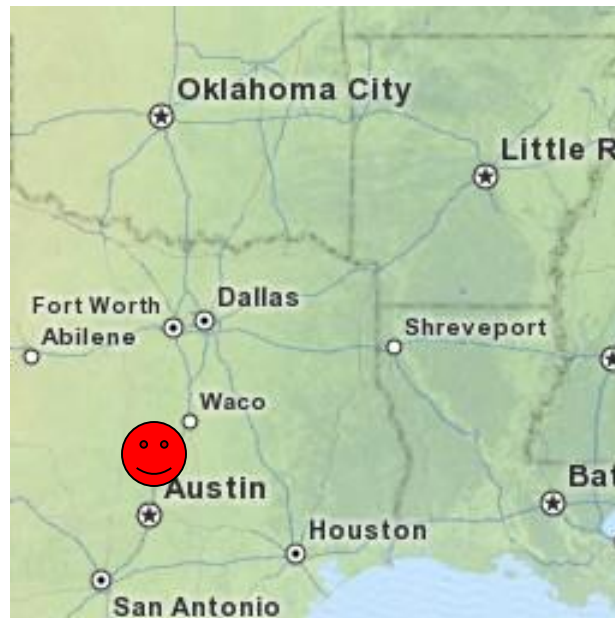
# Fingerprints forever

Killeen, Texas  
Double homicide May 2007



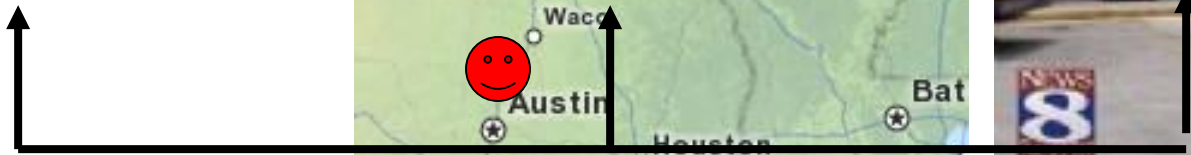
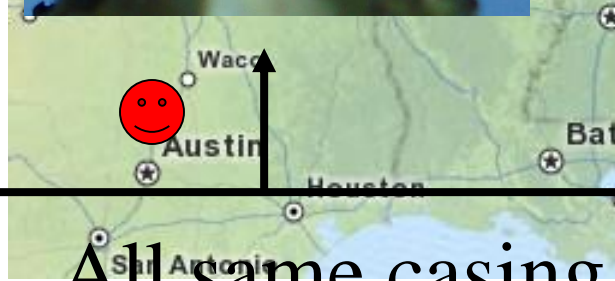
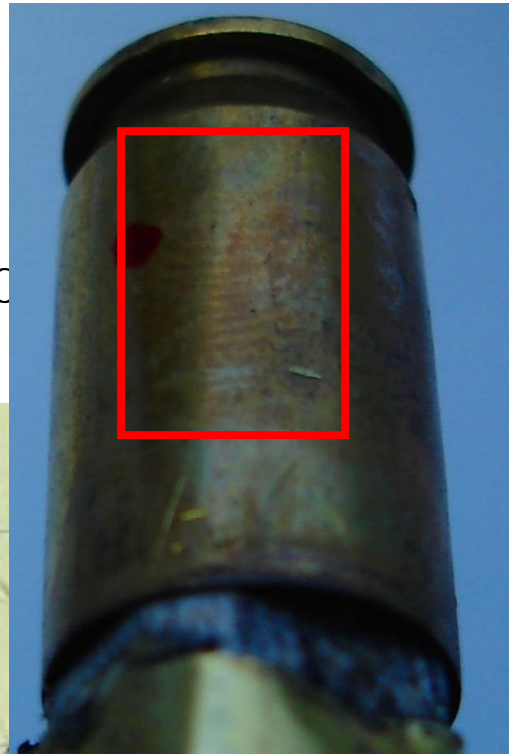
# Fingerprints forever

Killeen, Texas  
Double homicide May 2007





# Fingerprints forever



All same casing

# Fingerprints Forever

Method 2 : optical interference  
+ digital colour mapping

# Fingerprints forever



0.82:0.8:0.34



More yellow

0.83:0.86:0.83

R:G:B colour deconvolution

# Fingerprints forever



0.82:0.8:0.34



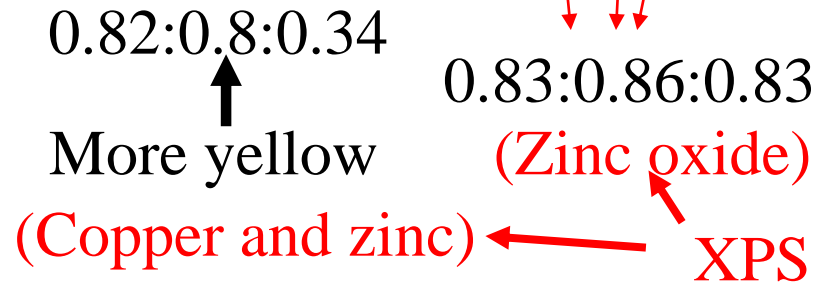
More yellow

0.83:0.86:0.83

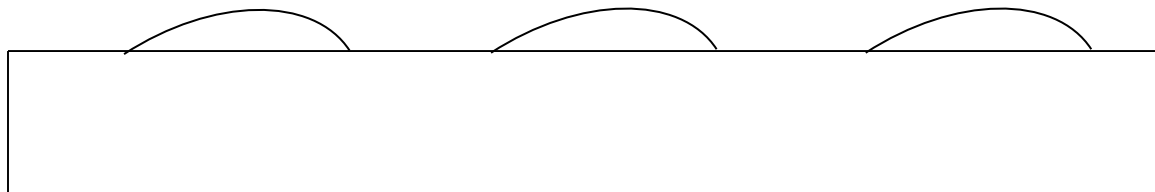
(Zinc oxide)

(Copper and zinc)

XPS

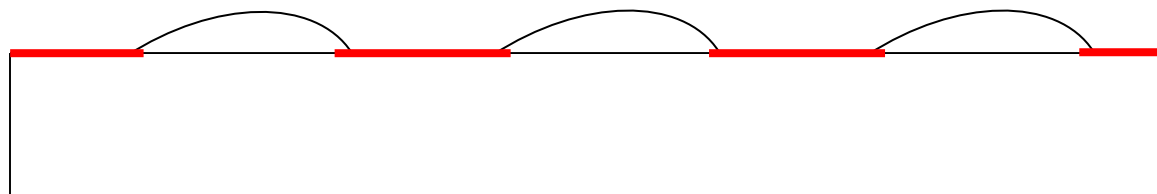


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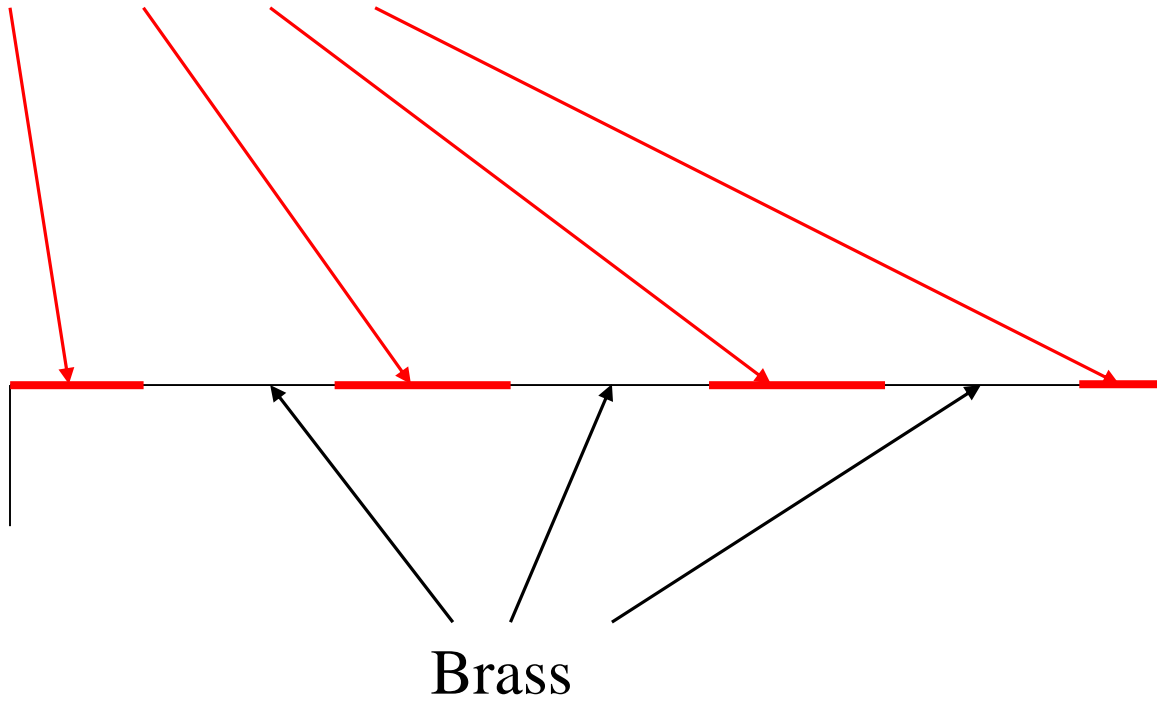


# Fingerprints forever

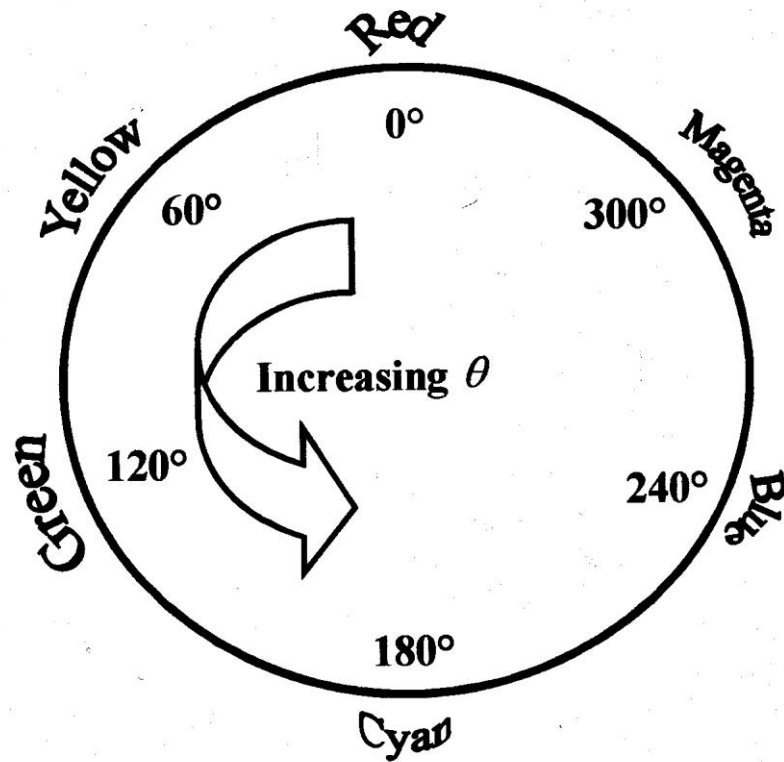


# Fingerprints forever

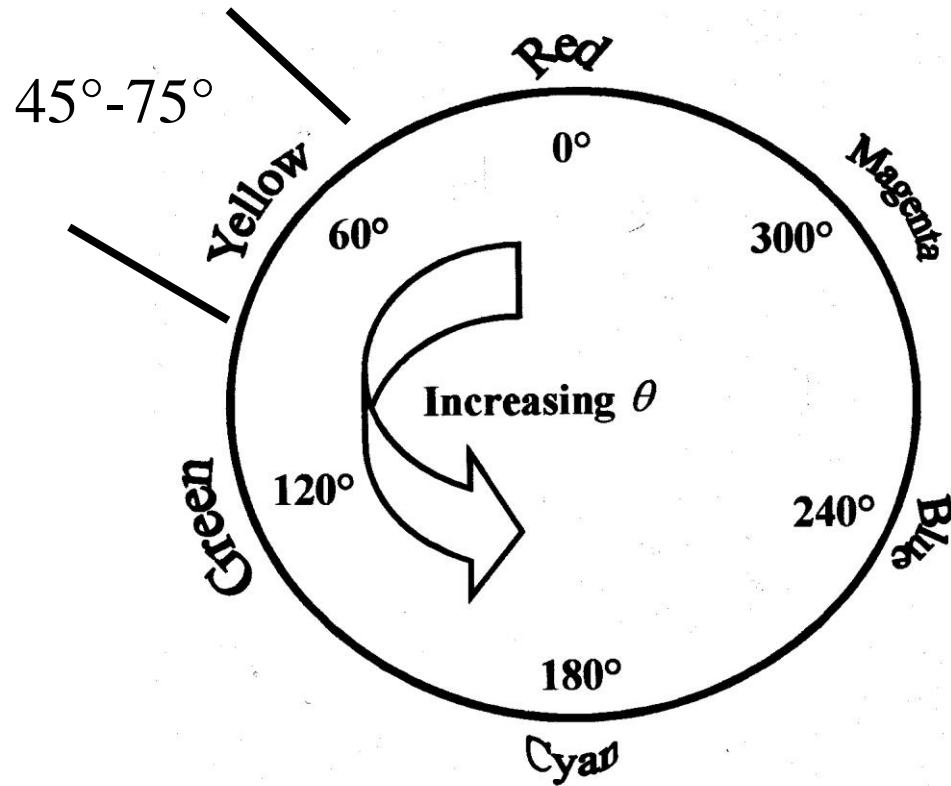
Zinc oxide corrosion



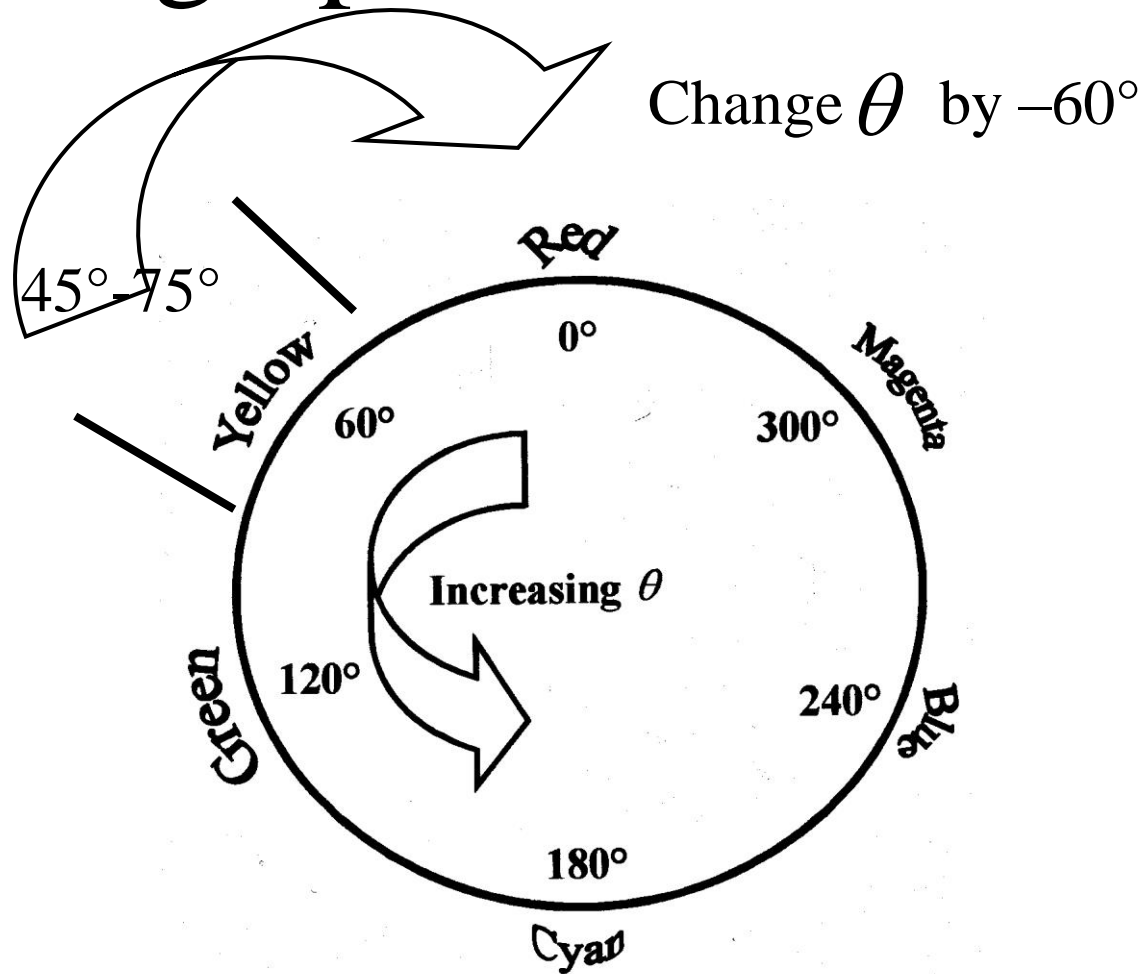
# Fingerprints forever



# Fingerprints forever



# Fingerprints forever





# Fingerprints forever



# Fingerprints forever



# Fingerprints forever

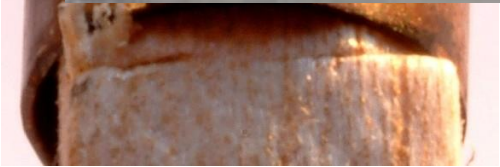
Tinley park, Illinois  
Five homicides February 2008



# Fingerprints forever



Illinois  
February 2008



# Fingerprints forever



**BISHOP**



**CHIUSO**



**MCFARLAND**



**SZAFRANSKI**



**WOOLFOLK**





# Fingerprints forever



Created by the Tinley Park Police Department in cooperation with the surviving victim.



# Fingerprints forever



NASA helped investigators enhance stills to try to identify a possible getaway car.

# Fingerprints forever



# Fingerprints forever





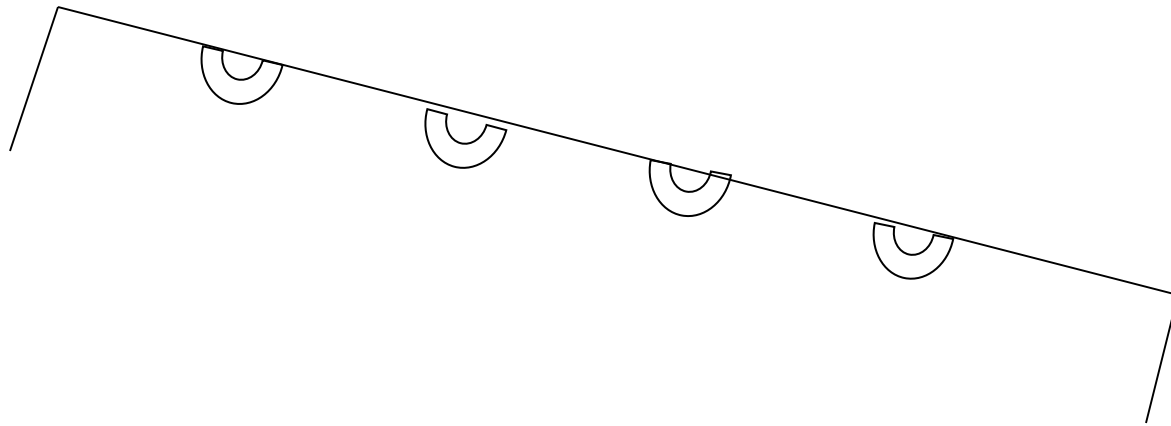
# Fingerprints forever



# Fingerprints Forever

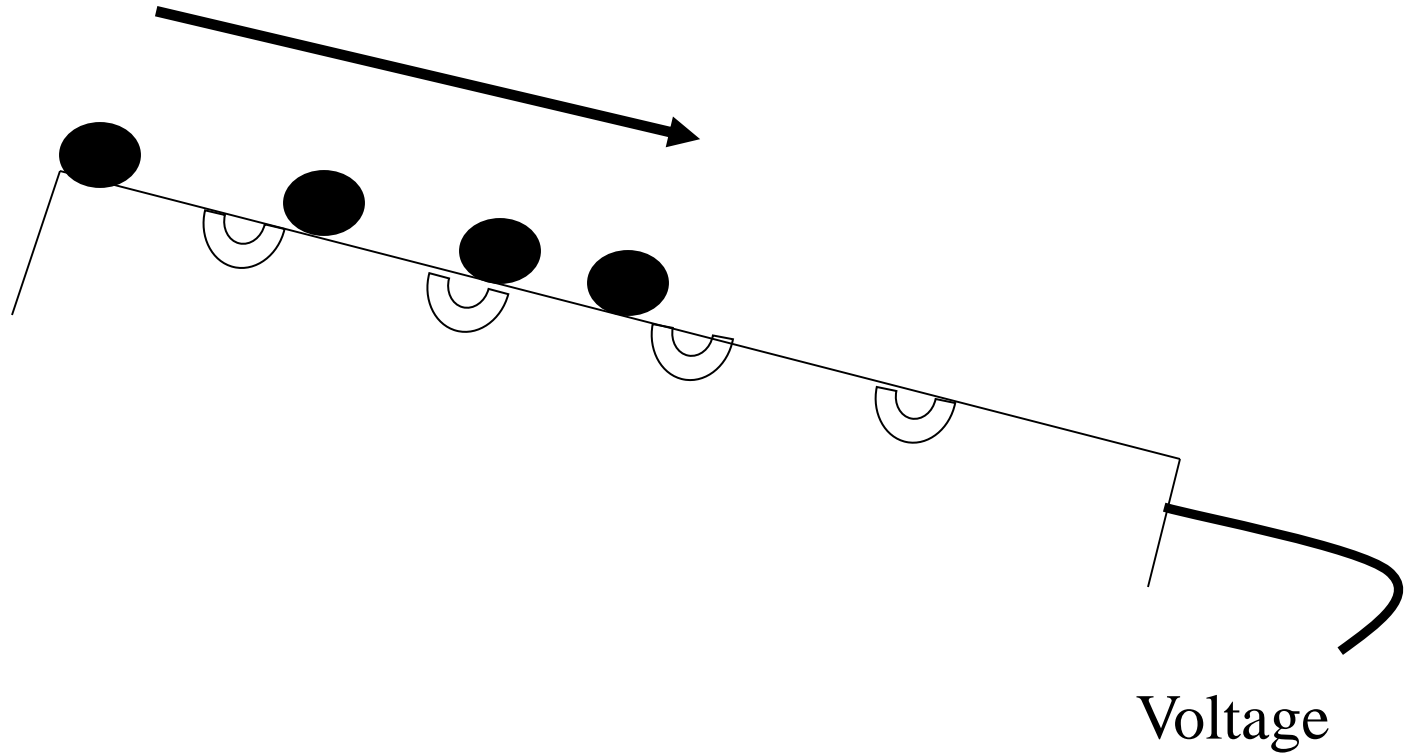
Method 3 : electrostatic enhancement

# Fingerprints Forever

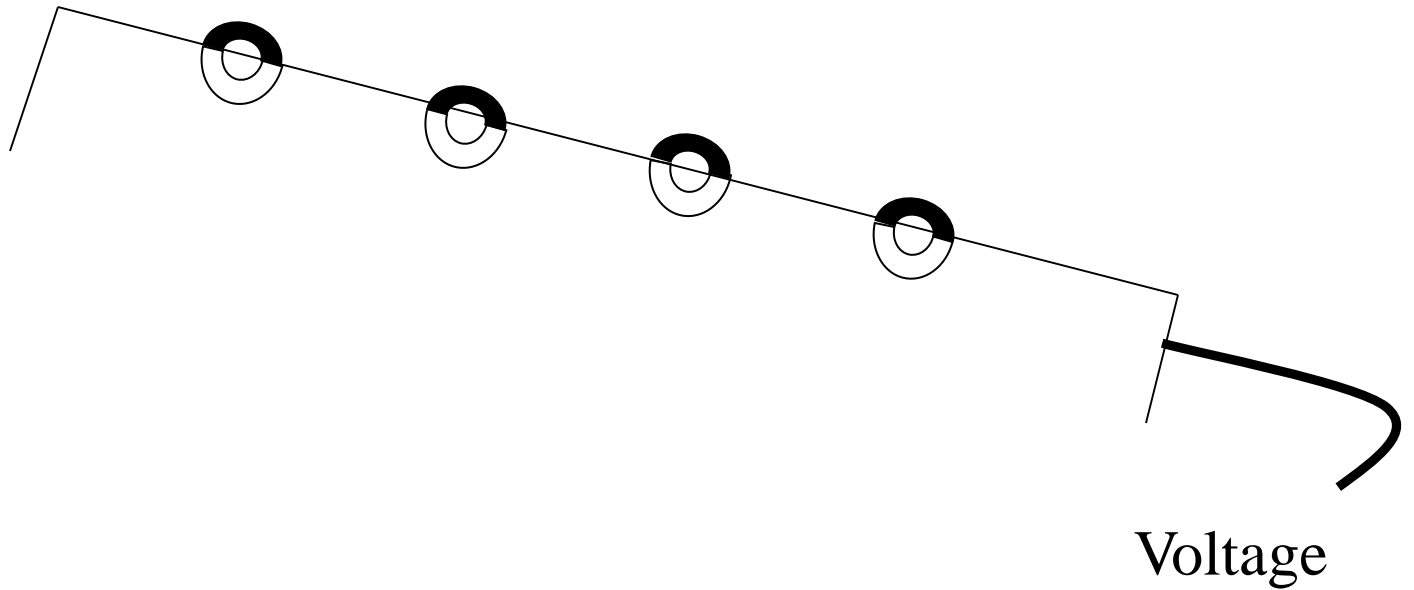




# Fingerprints Forever



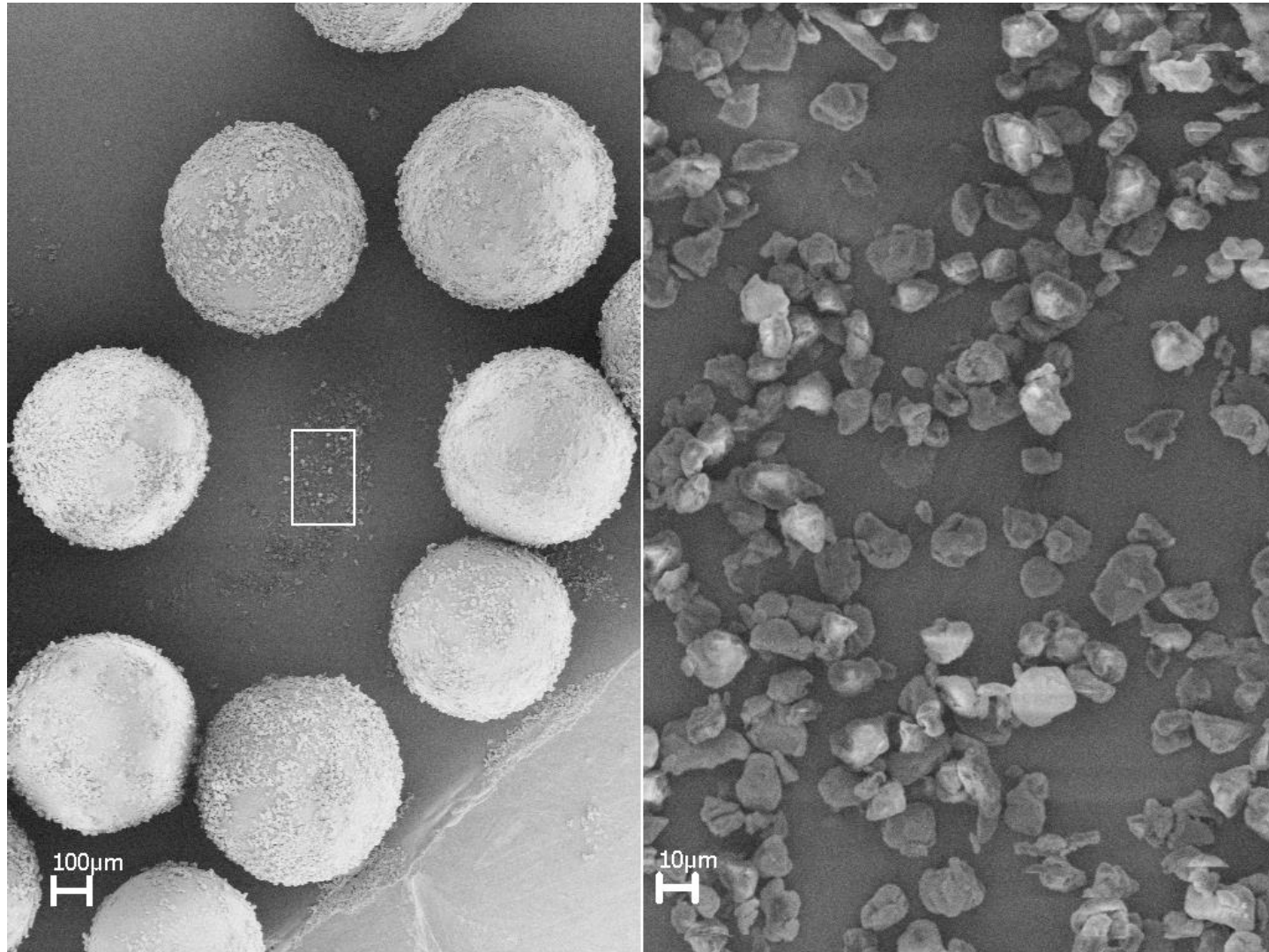
# Fingerprints Forever



# Fingerprints Forever



# Fingerprints Forever



# Fingerprints Forever



Fingerprint sweat removed by washing in soapy water

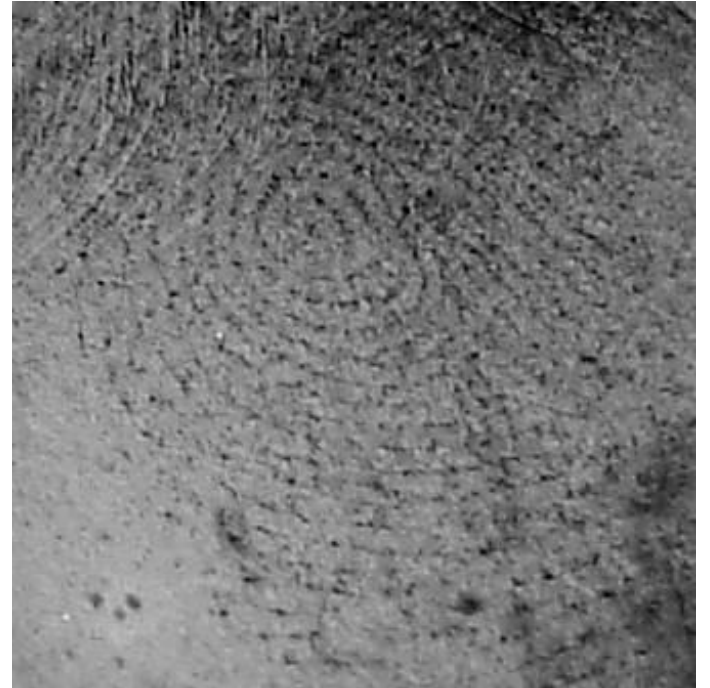
# Fingerprints Forever



Washed

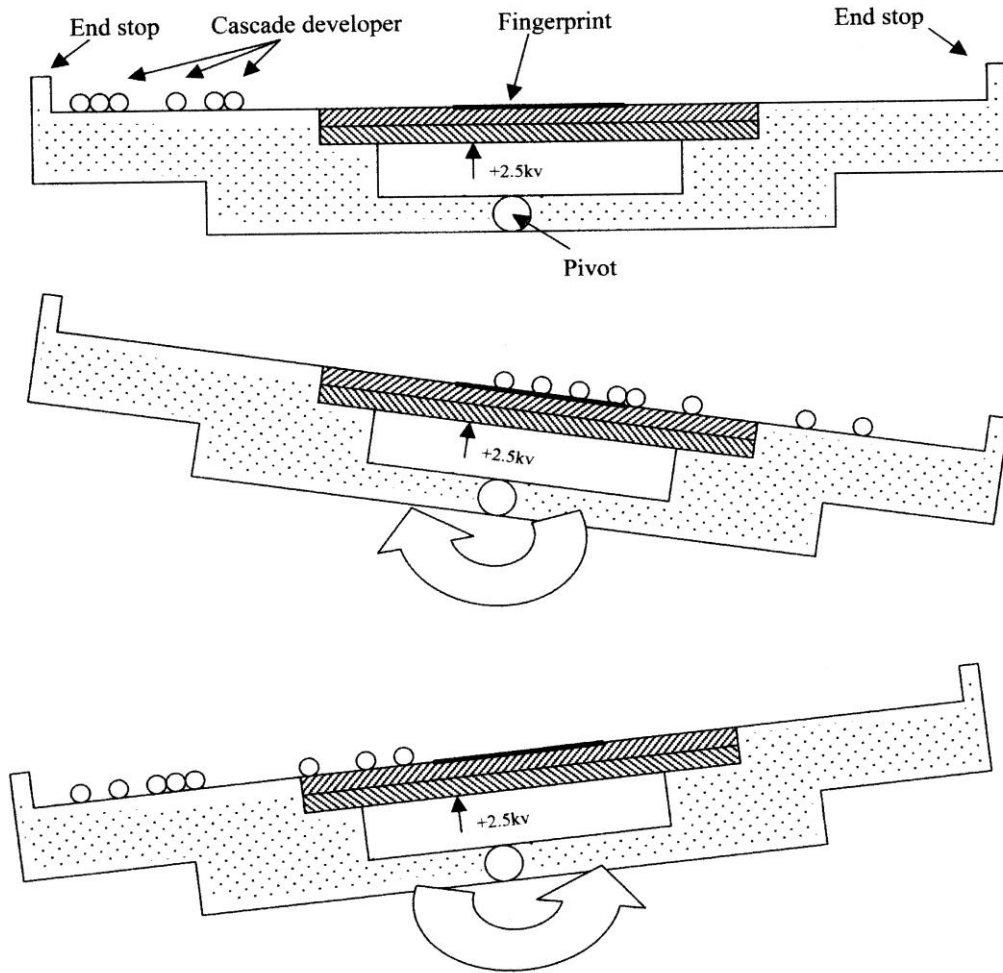


Enhanced






Re-washed and re-enhanced





**Key**

-  Charged metal disc
-  Test metal disc with fingerprint
-  Plastic frame

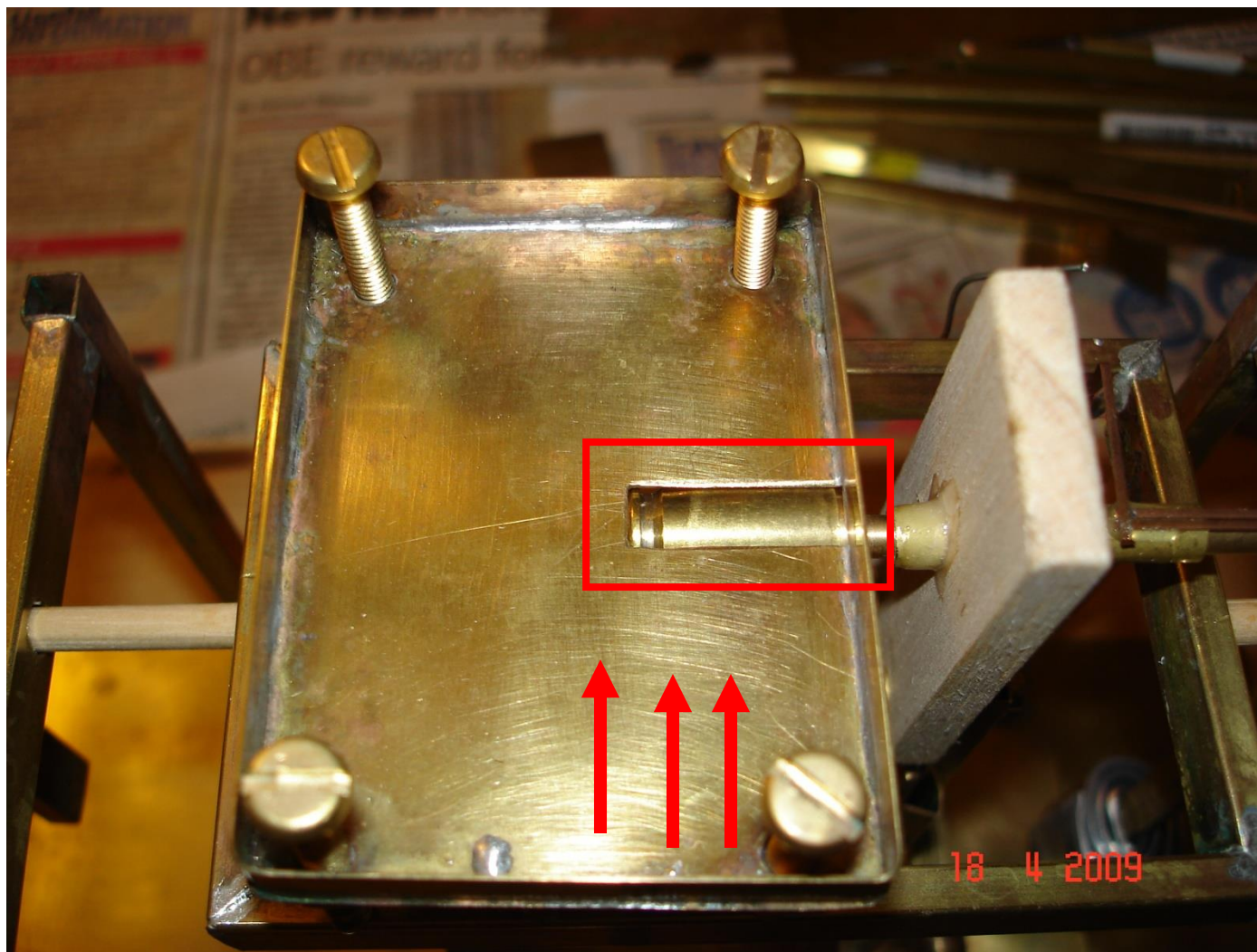
# Fingerprints Forever



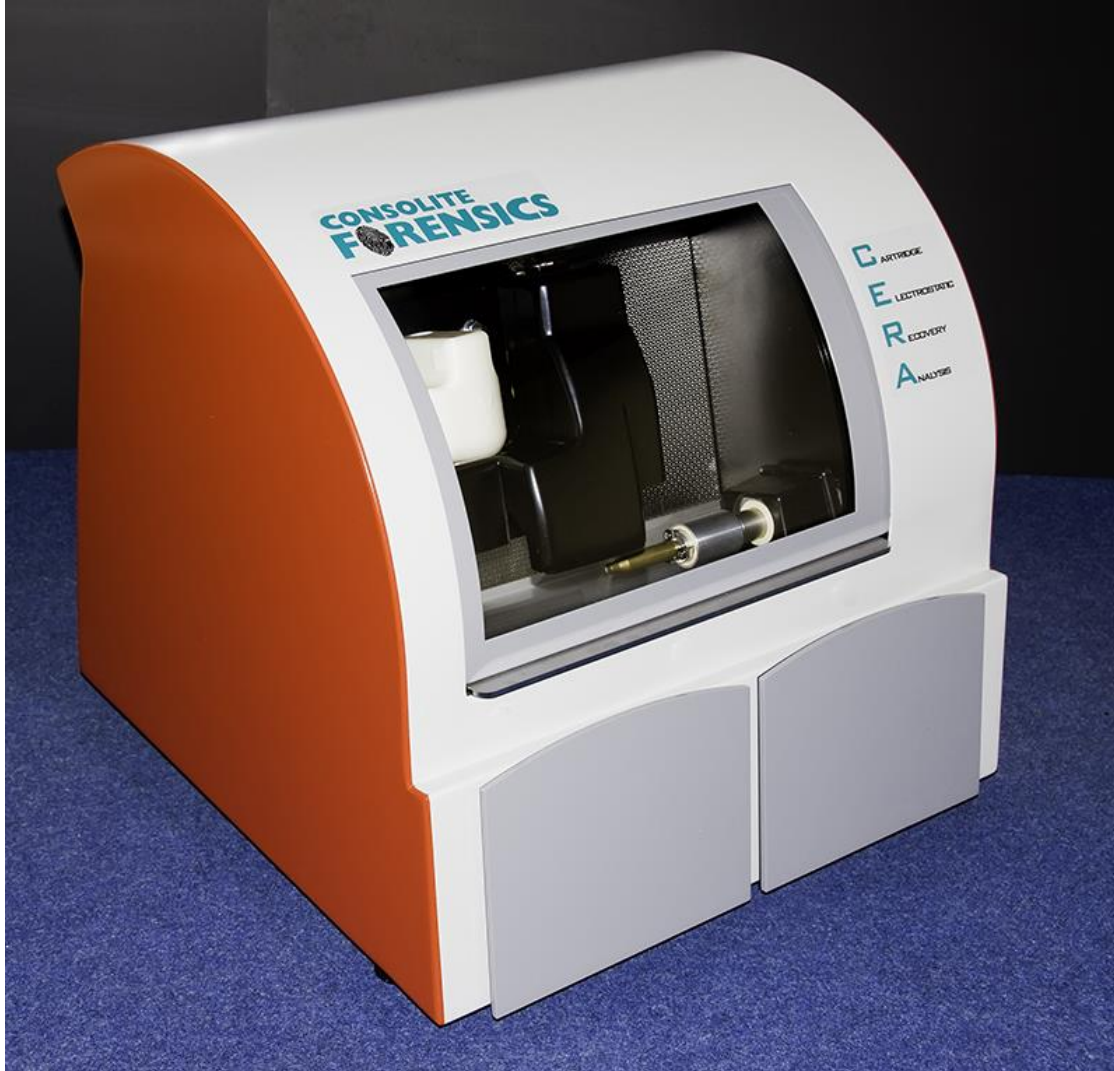
# Fingerprints forever



# Fingerprints forever







# Fingerprints forever

Kingsland, Georgia  
Double homicide 1999

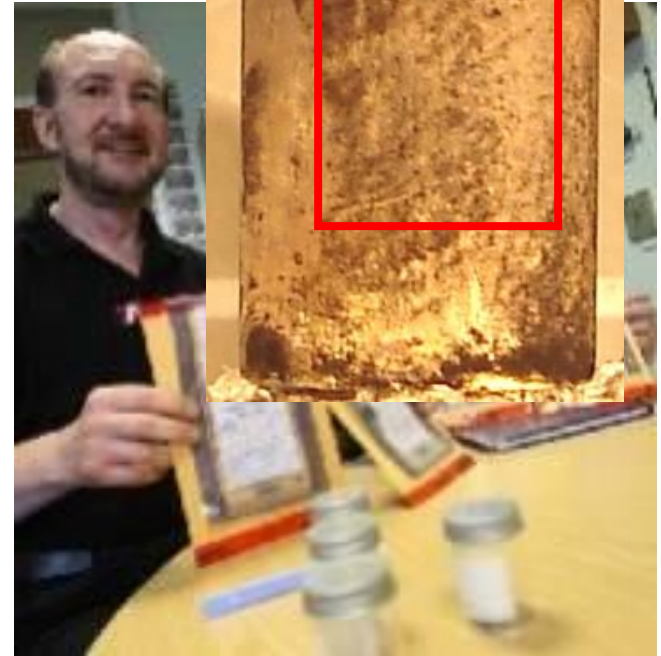




# Fingerprints forever



Georgia  
June 1999



Same casing

# Fingerprints Forever

Method 4 : Try washing it!

# Fingerprints forever

North Richland Hills, Texas  
Homicide December 2007



# Fingerprints forever



Richland Hills, Texas  
homicide December 2007





# Fingerprints forever



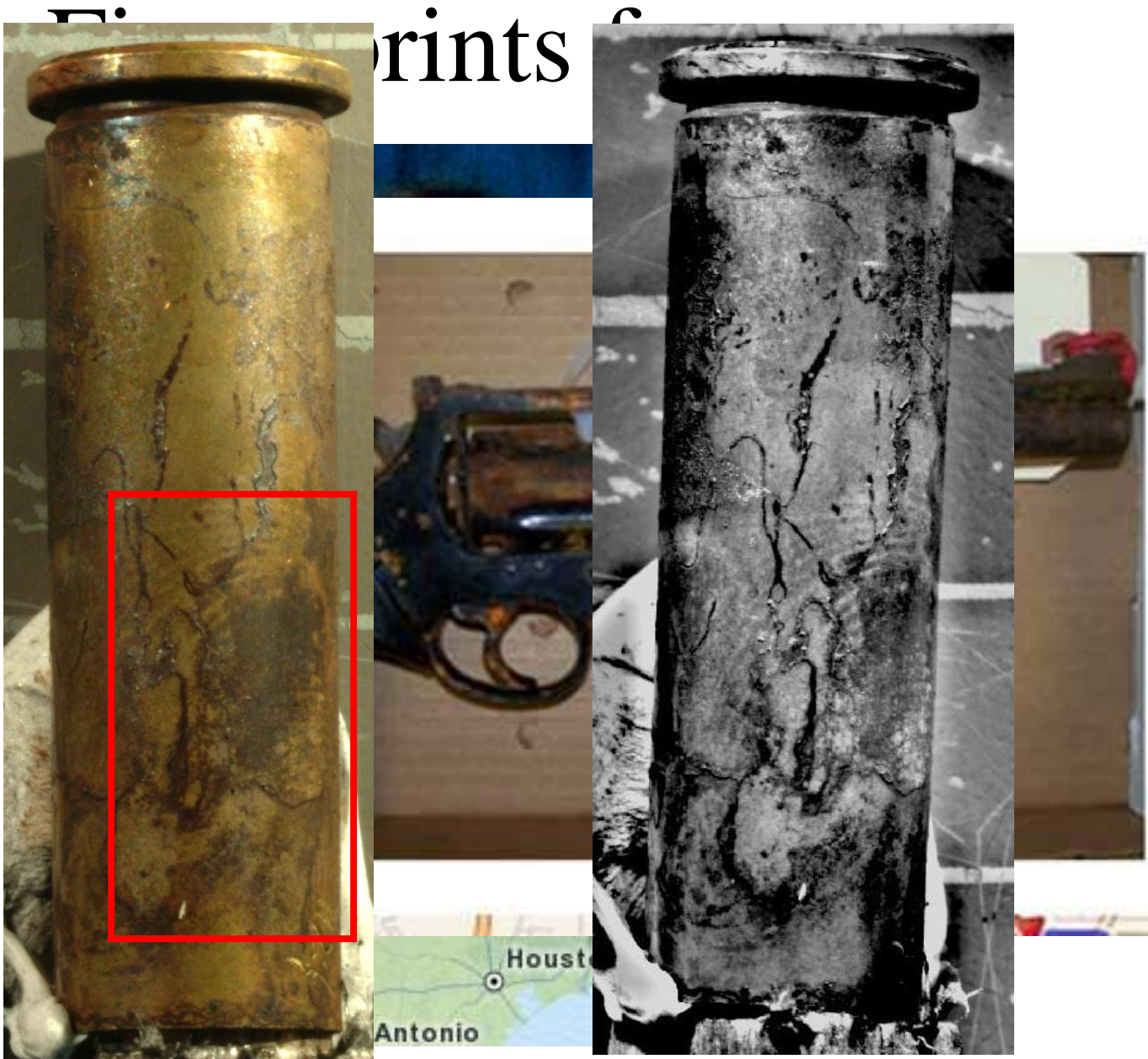
ls, Texas  
er 2007





# Fingerprints forever





# Fingerprints forever





# Fingerprints forever



# Fingerprints forever

What's new?



# Fingerprints forever



Copper pipe bombs

# Fingerprints forever





Dynasafe explosion containment vessel

# Fingerprints forever



# Fingerprints forever





# Fingerprints forever



Frederick Dash and Bruce Judah, Bomb Technicians with the Jacksonville Sheriff's Office Bomb Squad



Samples from one pipe bomb, post –washing.

# 1. Folding of pipe



## 2. Work hardening

- Five fragments (chosen at random) from each of the three pipe bombs were measured for Vickers Hardness (HV) either side of the pipe wall.
- Compared with measurements from either side of the pipe wall of an unexploded piece of copper pipe.

Mean of 10 HV measurements across the surface calculated.

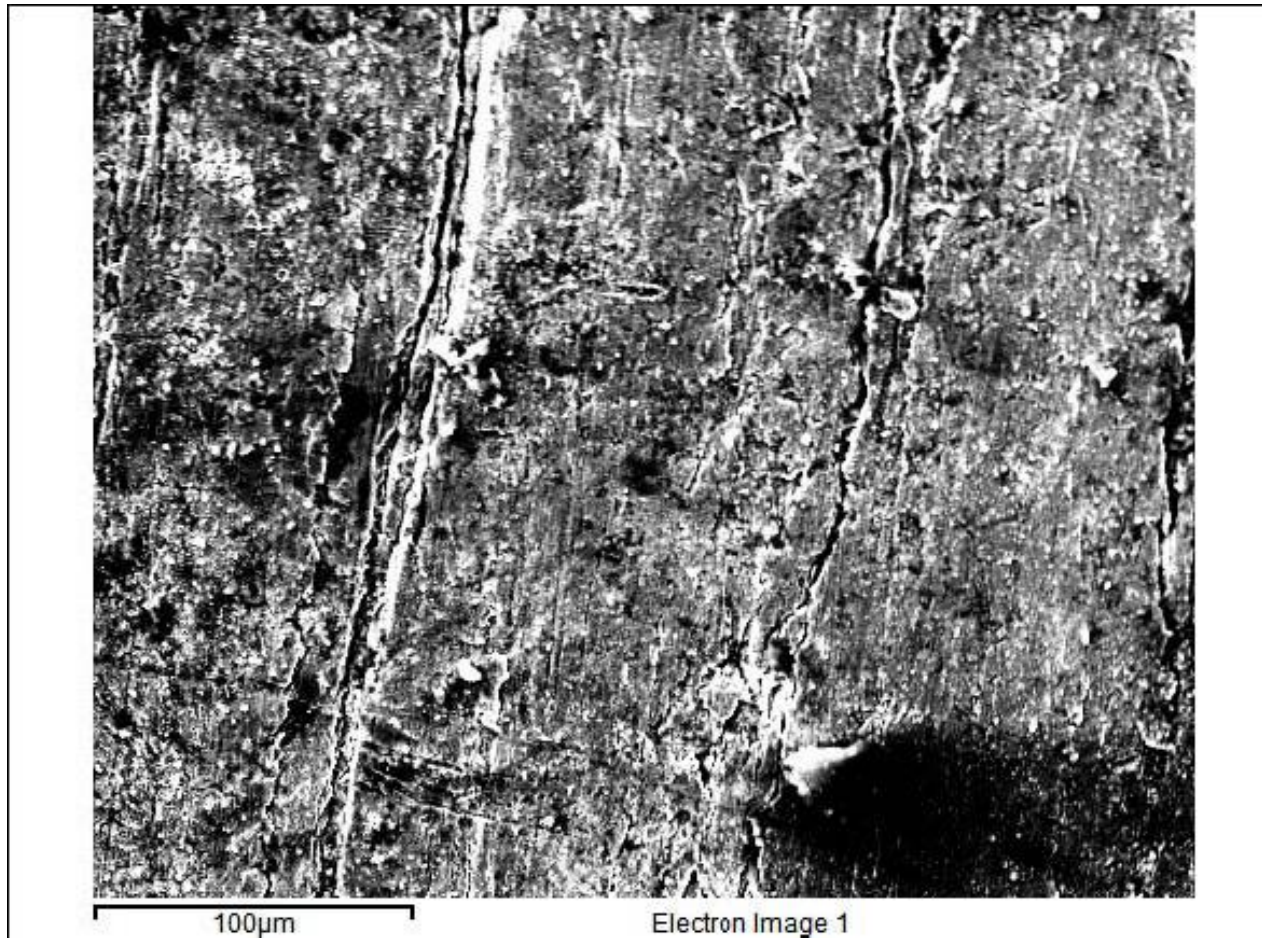
Values of HV were consistent either side of the pipe wall and between fragments.

Mean HV = 107 (107HV1), SD = 9.1.

Mean HV for unexploded copper pipe = 80 (80HV1), SD = 3.

(HV = 50 for annealed and 100 for work hardened copper).

### 3. Microfractures



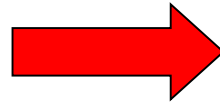
Parallel to the length of the pipe.  $\sim 100\mu\text{m}$  intervals,  $\sim 1\text{-}2\mu\text{m}$  in width.



## 4. Fingerprints



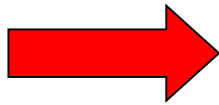
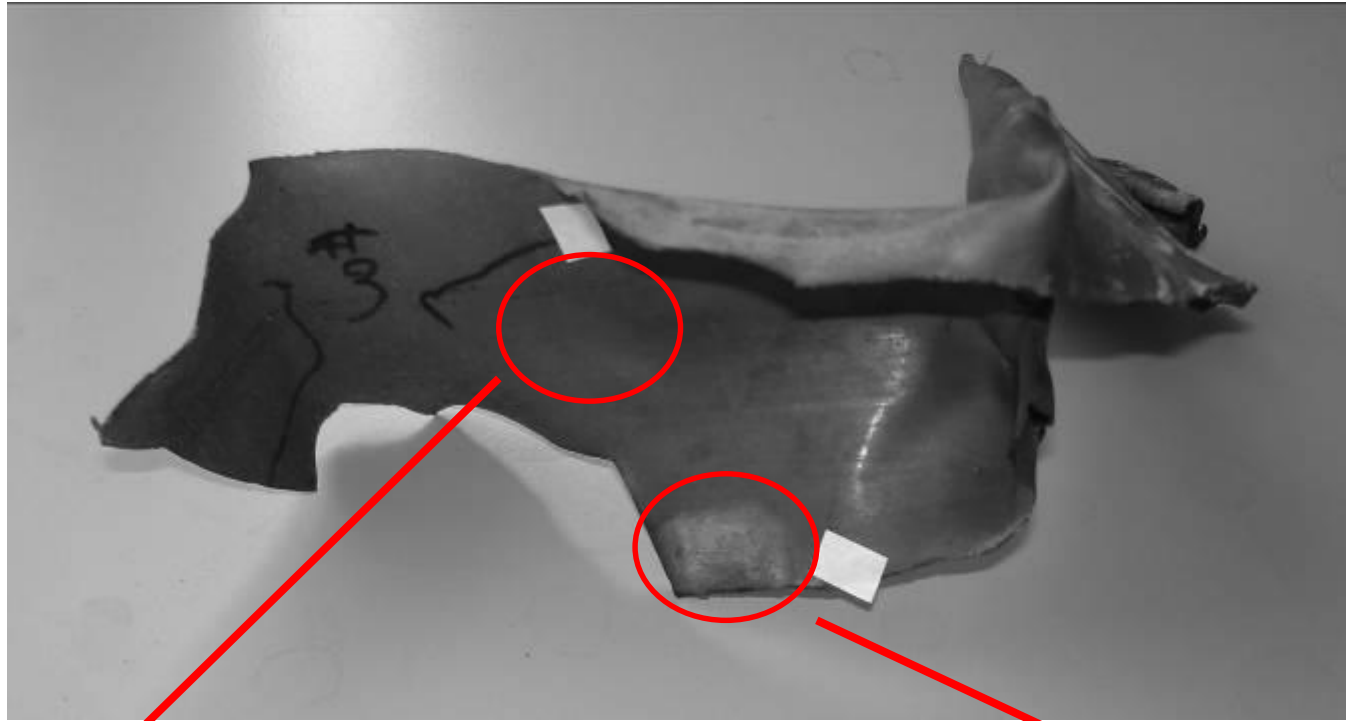
# Fingerprints forever



Enhanced

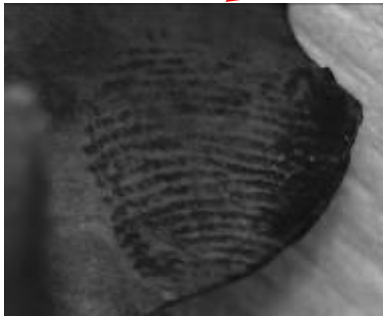
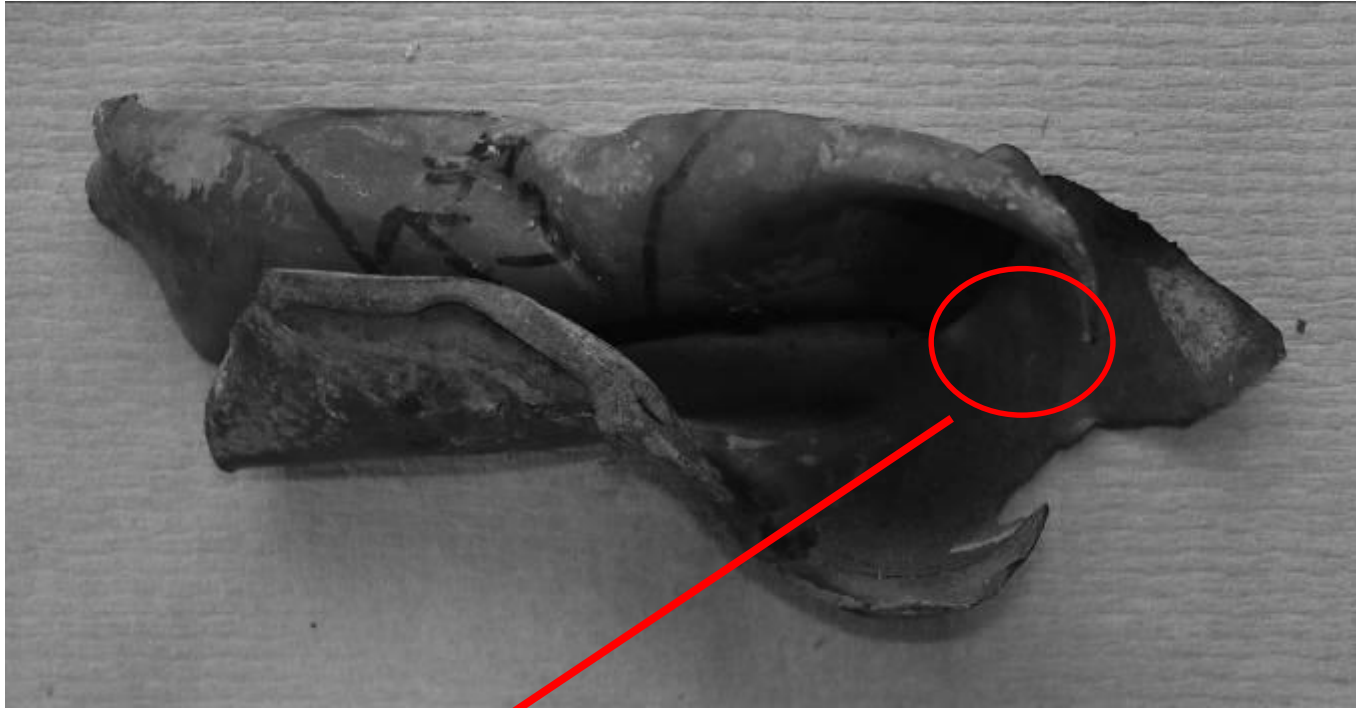


# Fingerprints forever



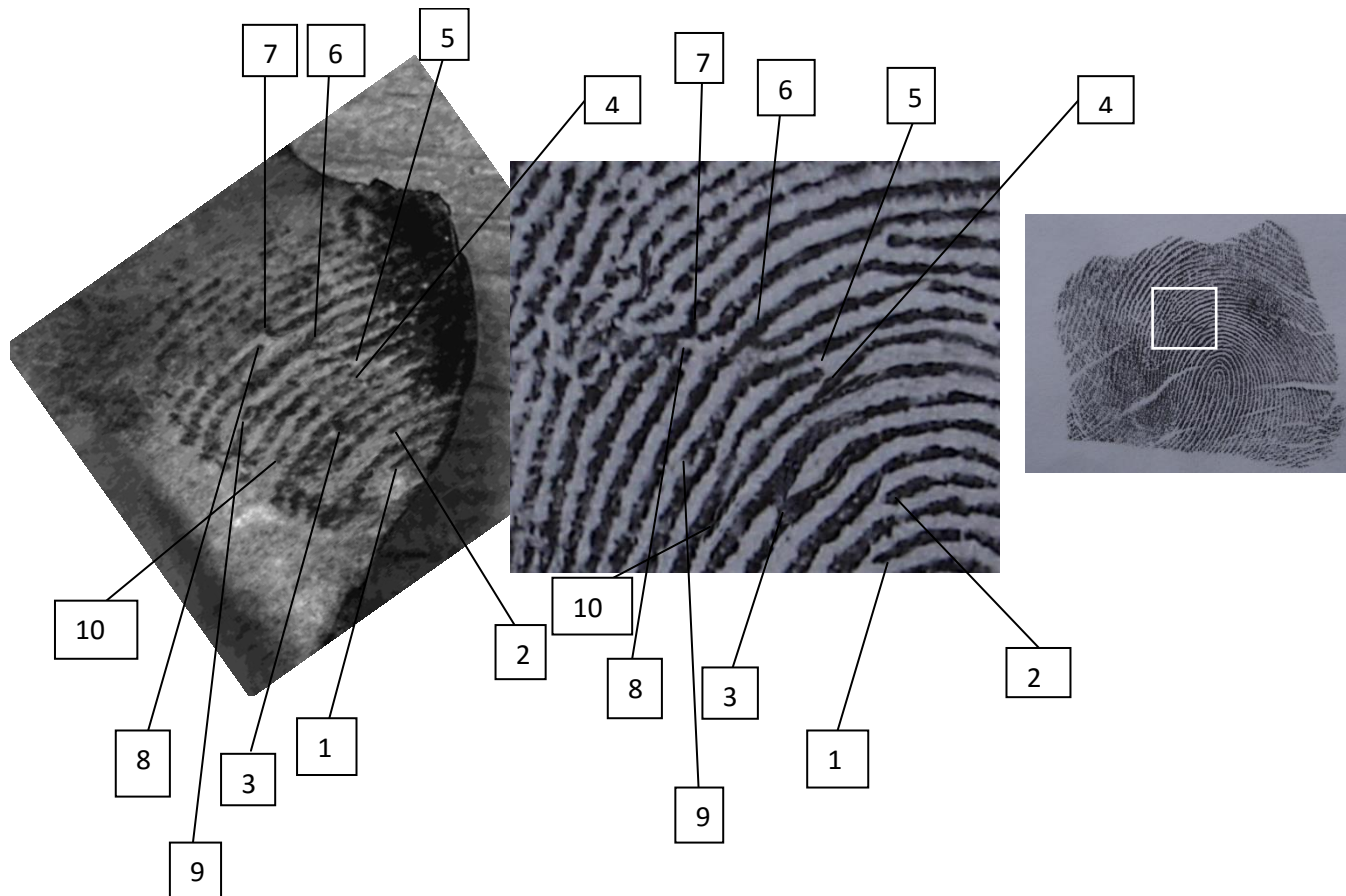
Enhanced





Enhanced







# Fingerprints For



39

## Enhanced Fingerprints.

English physicist John Bond has developed a technique for analyzing fingerprints on a gun's ammo even if it's been wiped clean. Sweat corrodes metal, so Bond applied an electrical charge and a fine carbon powder to a shell case's corroded part, revealing a fingerprint. Police are already using the four-month-old technology to reopen some cases.



## The Seven New Deadly Sins.

In March the Vatican updated the traditional seven deadly sins with seven new social sins, to bring the list into line with the temptations of the modern world. The additions: bioethical sins, morally dubious experiments that harm human embryos, drug abuse, polluting, social injustice, accumulating excessive wealth and creating poverty.



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# The Large Hadron Collider.

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If someone invented a practical 200-m.p.g. (1.18 L/100 km) automobile and that automobile got a flat tire, nobody would claim that the car itself was a failure. The same applies to the Large Hadron

Collider, the world's biggest particle accelerator, which went online in September, ran for 10 days and then had to shut down at least until next spring because of an overheated wire. The mammoth machine will send protons wheeling in opposite directions at nearly the speed of light, then smash them together at 6,000 times a second to try to answer such deep questions as why mass exists and whether the universe has extra dimensions. If it takes a few extra months to find out, so what?



# Fingerprints forever

## The Judges



**SIR JAMES DYSON**  
If any name is synonymous with innovation, it's his. He's not only reinvented the vacuum cleaner and the hair dryer, he's also the inventor of the world's best hover chair and the world's best hover car.



**LESLIE GAINS**  
As a futurist for BT, Lesley spends her day following industry trends and predicting what will be the next big thing. Before joining BT, she was an accomplished author and ran her own business.



**RICHARD NOBLE**  
Richard holds the land speed record from 1982-1987. He was project director of the XPRC, the car that holds the current world record, and is leader of the Bloodhound LSR, set to break 1000mph.



**JIM DINSDALE**  
Famous for being the man who solved BSC's long-term energy problem, Jim is the creator of the world's most advanced nuclear and nuclear power plants and nuclear power plants. He's also the man who helped solve the world's most complex energy problem.



Britain really has got talent. And here, according to our team of expert judges, are the British innovations that you should be looking out for over the next few years...

**A**s a nation we're always more than ready to come up with an idea and make it work. Everything from our eyes to the modern decorations of the flesh have evolved the same way. And it's a tradition that

continues today – you only have to watch a Formula One race to see that British country is alive and kicking. No other country has more talent on the start grid.

So, here at Focus, we decided it was high time to recognize Britain's talent for innovation and creativity. We drew up a shortlist of exciting new inventions and recruited a panel of expert judges to pick the best of the best. And here they are – the British innovations that are most likely to have the biggest impact on the world in the next few years. Remember, you saw them here first...

## The robot with greater reach

**DC Robotics, Britain**  
Founded by Dr Bob Dunningham and Andrew Gledhill

Industrial robots have always tended to do their stuff in wide-open spaces – think car plant sized dimensions. But this robotic arm is designed to get into the nooks and crannies that the others cannot reach. Whether it's inside a nuclear reactor, aircraft or even inside the human body, this robot helps you build things or carry out repairs.

How it works is pretty simple. The robot's arm is built with a large number of magnetic segments, a bit like a human spine. "Tendon" wires terminate at

nerve points along the arm and a motor is used to control the length of each wire independently, shaping the arm exactly as you'd like it to be. The operator uses a joystick to drive the arm's tip and a computer calculates how to make the movements. A hollow bore runs through the arm's centre, allowing devices to be passed through. The arm could be used as anything from a manipulator in a vacuum.

Contracts have already been signed in, including one to fit an arm in a reactor so it can be used to inspect nuclear reactors in Canada. The MoD and the US Department of Defense are also showing interest. The company has also been working with Airbus UK to develop robots that can be used on the assembly line.



DC Robotics' snake-arm can get to all those hard-to-reach places

## MINI MARVELS

### BIG BUSINESS

Miniature, reusable batteries need to generate electricity in an inaccessible area like the inside of a car engine to help to reduce fuel consumption. The batteries are powered by many tiny fuel cells in a car's engine. They can get better results from rice and coffee fresh water. These water molecules are heated to very high temperatures to produce hydrogen gas emissions, making for an efficient and environmentally friendly power generation.



### AIR BATTERY

Researcher at the University of Cambridge have developed a new type of battery. Currently use lithium rechargeable, which is heavy and costly. The new STAIR DC (Staircase Air) cell can use paper instead. This means you get a cheaper, lighter battery with about 30 times more life. The batteries are likely to become commercially available in about five years, a development that could have a big impact in many fields, not least the electric car industry.



## Indelible prints

**Dr John Bond, University of Leicester**

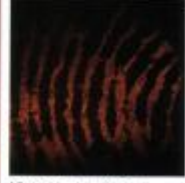
Clifford who smashes a stretchy surface will no longer be able to wipe that surface clean, thanks to Dr John Bond, a fellow of the University of Leicester and scientific support manager for Northamptonshire police. Dr Bond has come up with a way to detect the corrosion on metal surfaces caused by tiny traces of salt present on human fingers. What's more, he built his device at home using wine and gutter tape.

Dr Bond first applies 2000 Volts to the metal being tested. This creates bonds, coated with a fine powder similar to that used in photocopiers, are similarly charged and powered onto the metal. The powder sticks where corrosion has taken place, and is baked to hold its pattern. It's then photographed for fingerprint comparison. The marks it produces cannot be wiped off, and do not deteriorate.

The invention has attracted interest from US detective looking for so-called cold cases, as well as military command in Afghanistan who believe it could help them track down those who manufacture roadside bombs.



Dr Bond's technique makes prints indelible



A fingerprint on a piece of brass



# Fingerprints forever

