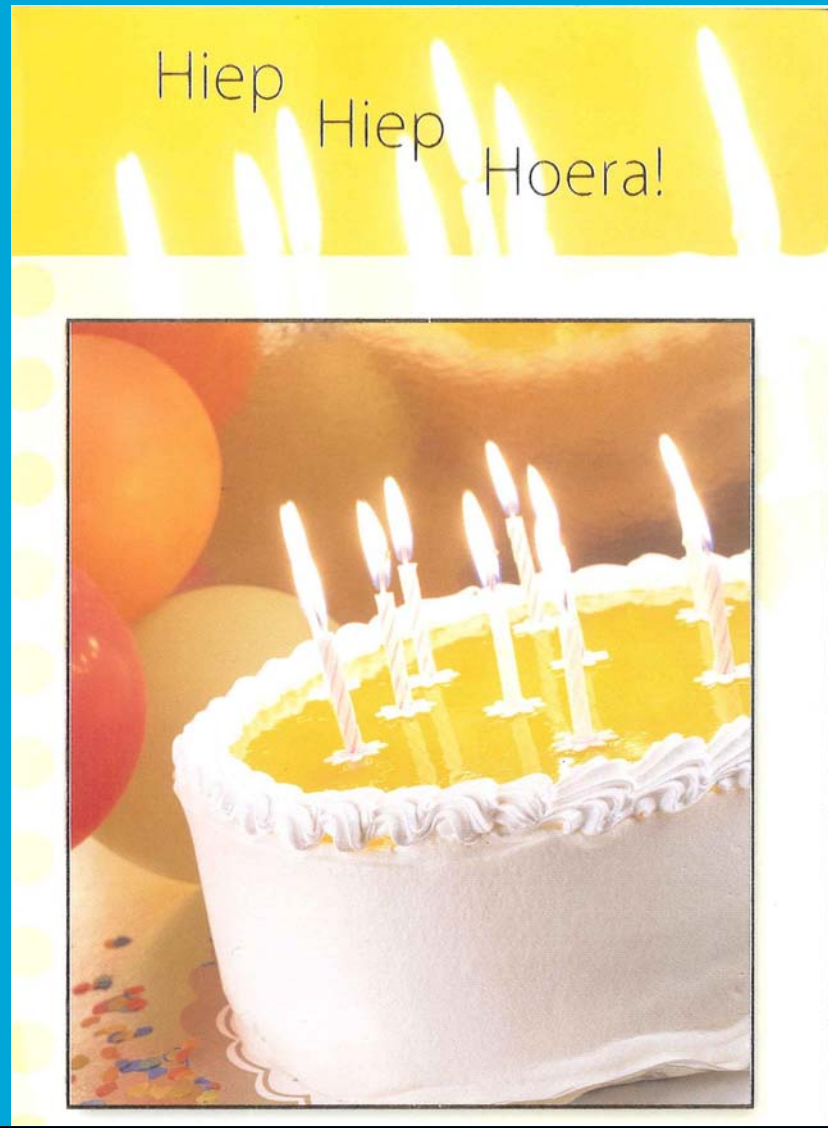
The Production of Nanoparticles by EHDA

and

some other aerosol surprises



10 ys PTL/ETH Symposium
July 4-8, 2008
Zurich, Switzerland

Jan C.M. Marijnissen
TU Delft. DCT, The Netherlands

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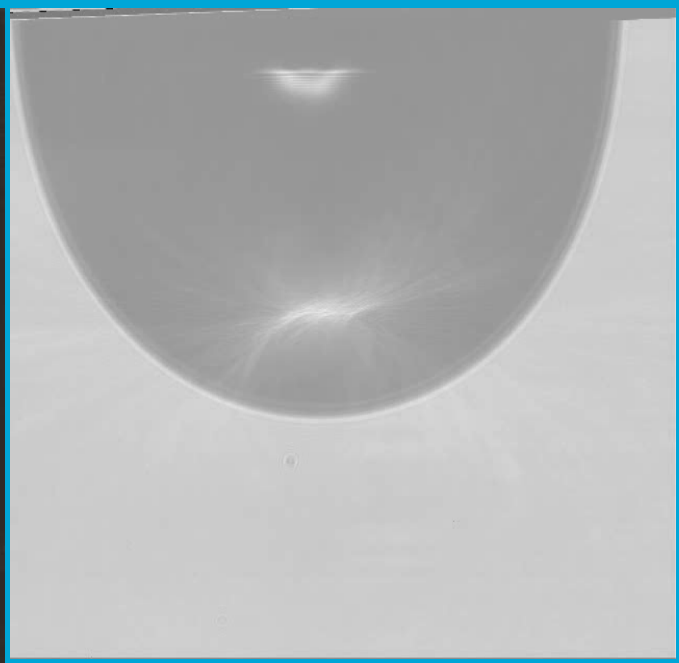

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Ambrose and William Gilberd have placed this tomb In memory of brotherly piety, To William Gilberd, Senior, Gentleman, and doctor of medicine. This, the eldest son of Jerome Gilberd, Gentleman, was born in the town of Colchester, studied the art of medicine at Cambridge, practiced the same for more than thirty years at London, with singular credit and success. Hence called to Court, he was received with highest favor by Queen Elizabeth, to whom, and to her successor James, he served as chief physician. He composed a book celebrated among foreigners concerning the magnet for nautical science. He died in the year of the Human Redemption 1603, the last day of November, in the 63d year of his age.

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vetur. Si aëris ſit affluxus, & impetus verſus corpus: quomodo exiguus Adamas, quantitate oribi, poteſt tantum aëris accerſere, ut rapiat majusculum corpus longum in æquilibrio poſitum (circa alteram tantùm finis minimam partem aëre allecto)? Oportebat etiam conſiſtere, aut tardiùs movere, antequàm corpus feriret, præſertim ſi latiùs fuerit & planum ſuccinum, ex congregatione aëris in facie ſuccini, & refluxione. Si quia tenuiora effluunt, & incraſſata reverſuntur, (ut in ſpiritalibus) tunc potiùs motum haberet corpus ad electricum paulò poſt principium applicationis; ſed cum celeriùs applicantur verſorio fricata electrica, tùm maximè appellat verſorium, magisq; in propin... ſi quia rara effluvia rarum efficiun... craſſiori in tenuius m... latere ſic...

It plainly attracts the body itself in the case of a spherical drop of water standing on a dry surface; for a piece of amber held at suitable distance pulls towards itself the nearest particles and draws them up into a cone.

...gates
... corpora, unicâ
...ulus horæ partem, præſer-
... moles ſuccini major fuerit, & ſuper-
...q; trictione allicit.

Silex teritur & emittit ab attritione materiam inflammabilem, in ſcintillas & ardores converſam. Silicis igitur effluvia craſſiora concipientia ignem longè plurimùm ab electricis effluvijs differunt, quæ propter ſummam tenuitatem ignem non concipiunt, nec flammæ ſunt materia idonea. Effluvia illa non ſunt flatus, nam emiſſa non impellunt quicquam, ſed abſq; ullâ ſenſibili retinentiâ effluunt, & attingunt corpora. Humores ſunt ſummè attenuati, aëre ambiente multò ſubtiliores, qui ut fiant requiruntur corpora ab humore prognata & majori duritie concreta. Non electrica corpora non ſolvuntur in effluvia humida, illaq; effluvia cum communibus & generalibus telluris effluvijs miſcentur, nec ſunt peculiaria. Etiam præter attractionem corporum, retinent ea diutius. Veriſimile eſt igitur ſuccinum exſpirare aliquid peculiare, quod corpora ipſa alliciat, non aërem intermedium: corpus verò ducit ipſum manifeſtò in aquæ globosâ guttâ poſitâ ſupra ſiccum, nàm Succinum appoſitum, in convenienti diſtantia, proximas convellit partes, & educit in Conum: Alioquin ſi ab aëre ruente adduceretur, gutta tota inclinaret.

Silex attritione emittit materiam inflammabilem.

Electrica corpora nõ ſolvuntur in effluvia humida.

Succinum allicit corpora non aërem.

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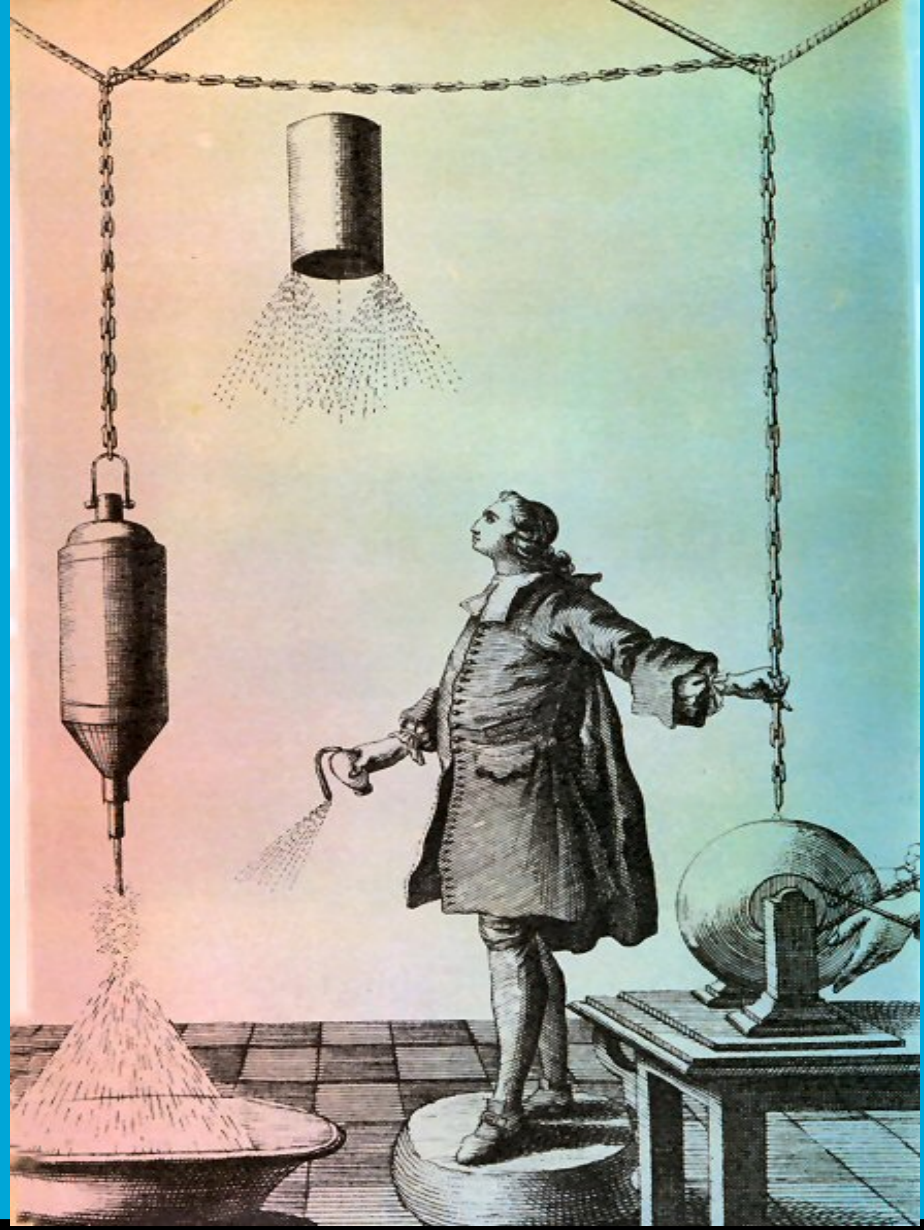

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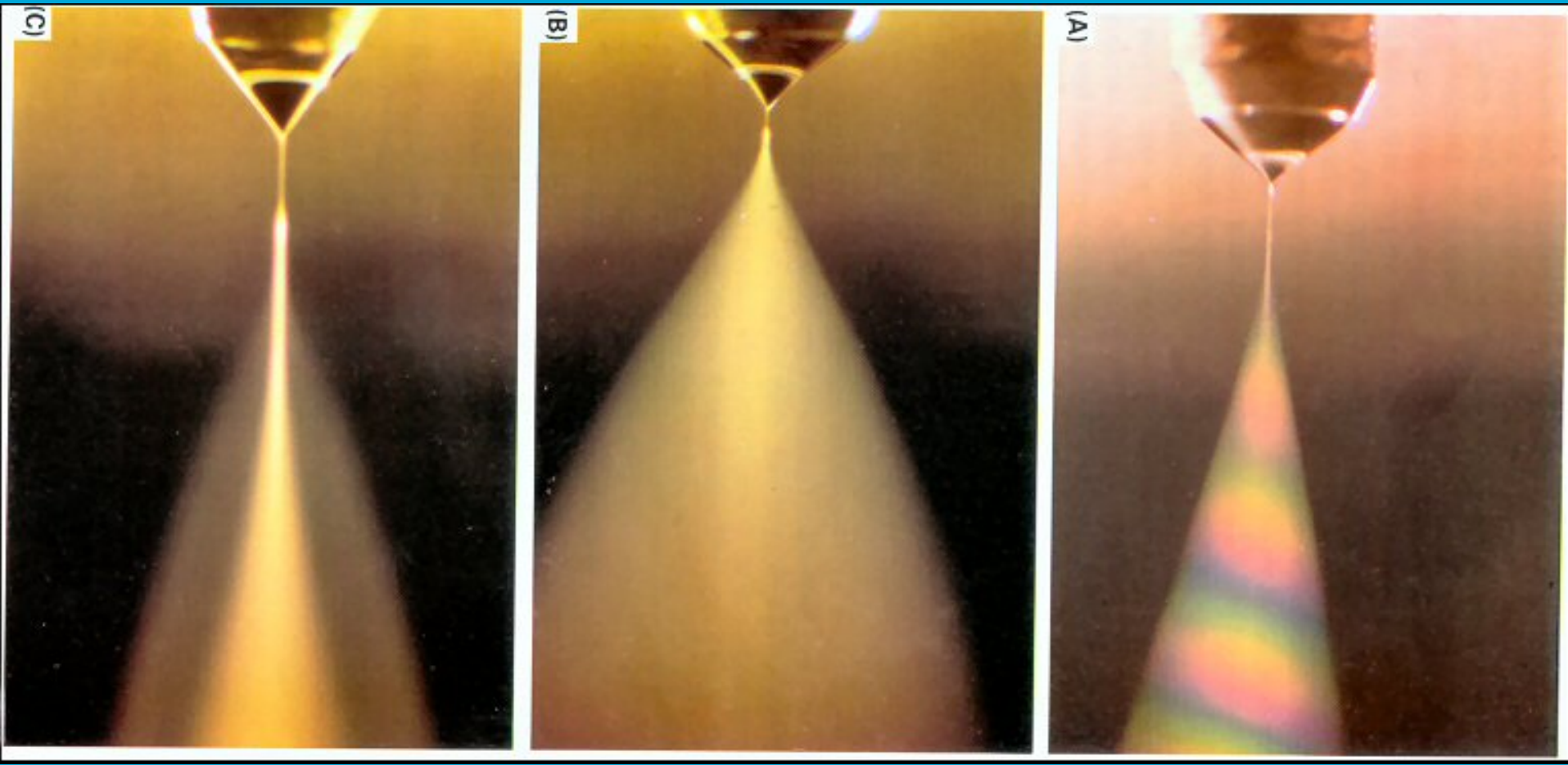

C. Pantano, A.M. Gañán-Calvo and A. Barrero, JAS, 1994, 25 (6),,1065

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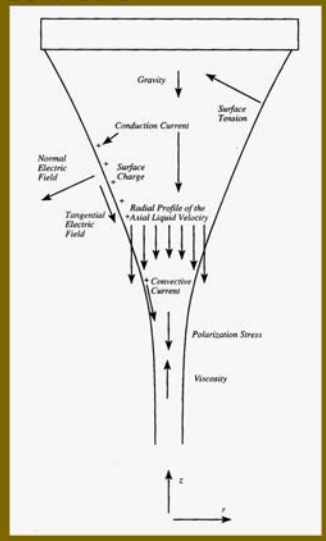
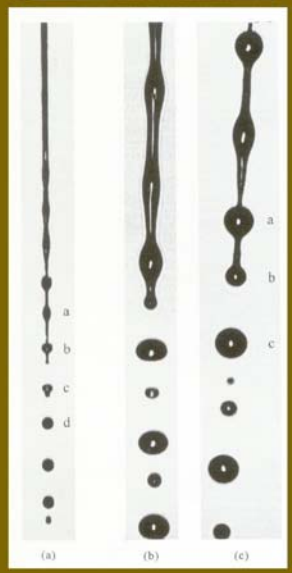
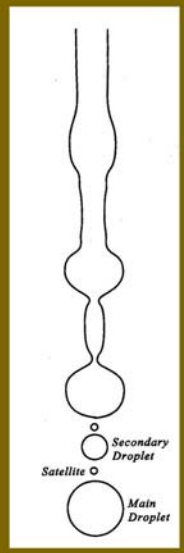
Electrohydrodynamic Atomization in the Cone-Jet Mode







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Scaling of droplet size and current EHDA cone-jet mode

For the current scaling for liquids with a flat radial velocity profile in the jet

$$I = b(\gamma K Q)^{\frac{1}{2}}$$

The droplet diameter for the varicose break-up mode is

$$d_{d,v} = c\left(\frac{\rho\varepsilon_0 Q^4}{I^2}\right)^{\frac{1}{6}}$$

Substituting equation 1 into equation 2 yields:

$$d_{d,v} = \left(\frac{16\rho\varepsilon_0 Q^3}{\gamma K}\right)^{\frac{1}{6}}$$

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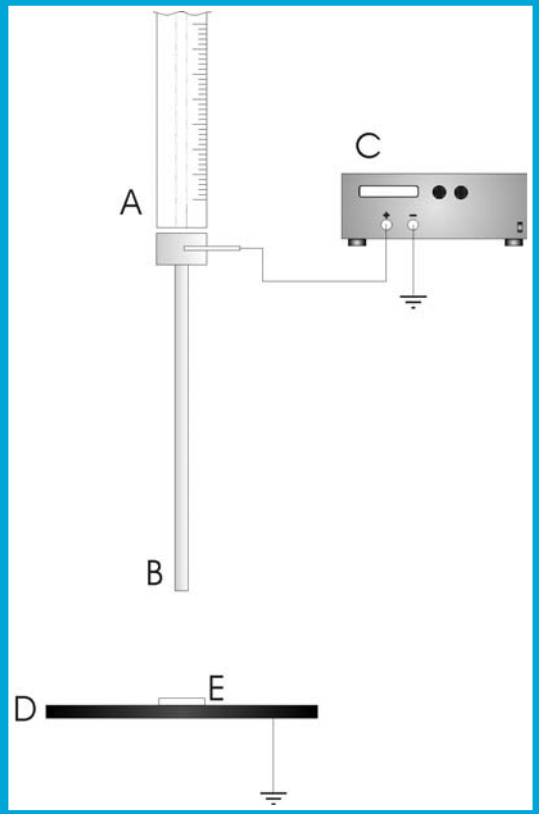
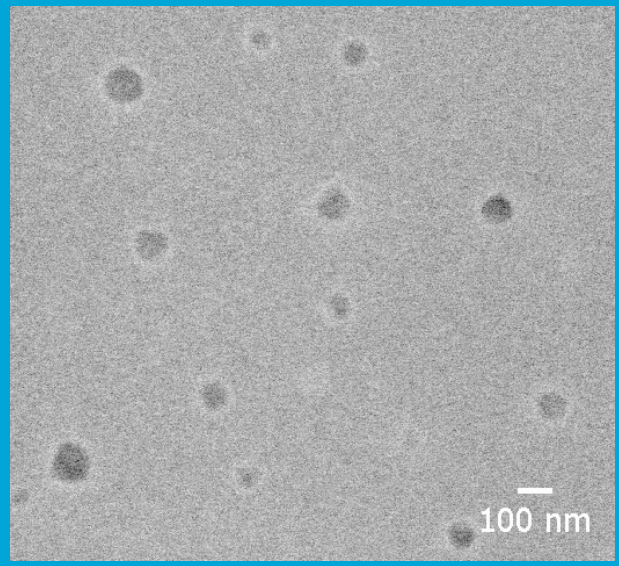
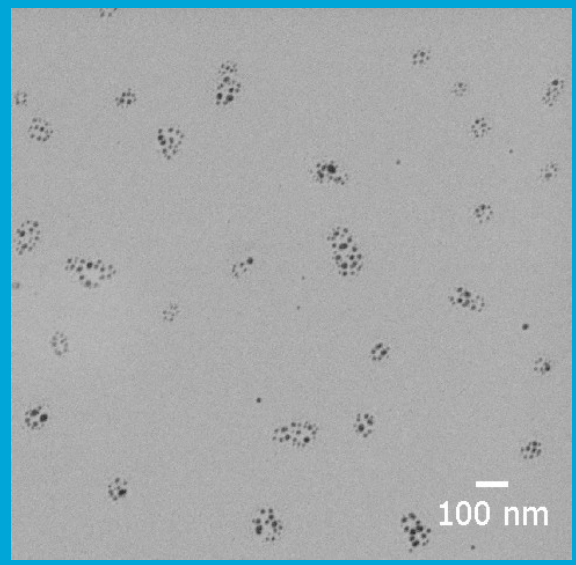
Pt nanoparticles capillary-plate method





10 min @ 700 °C



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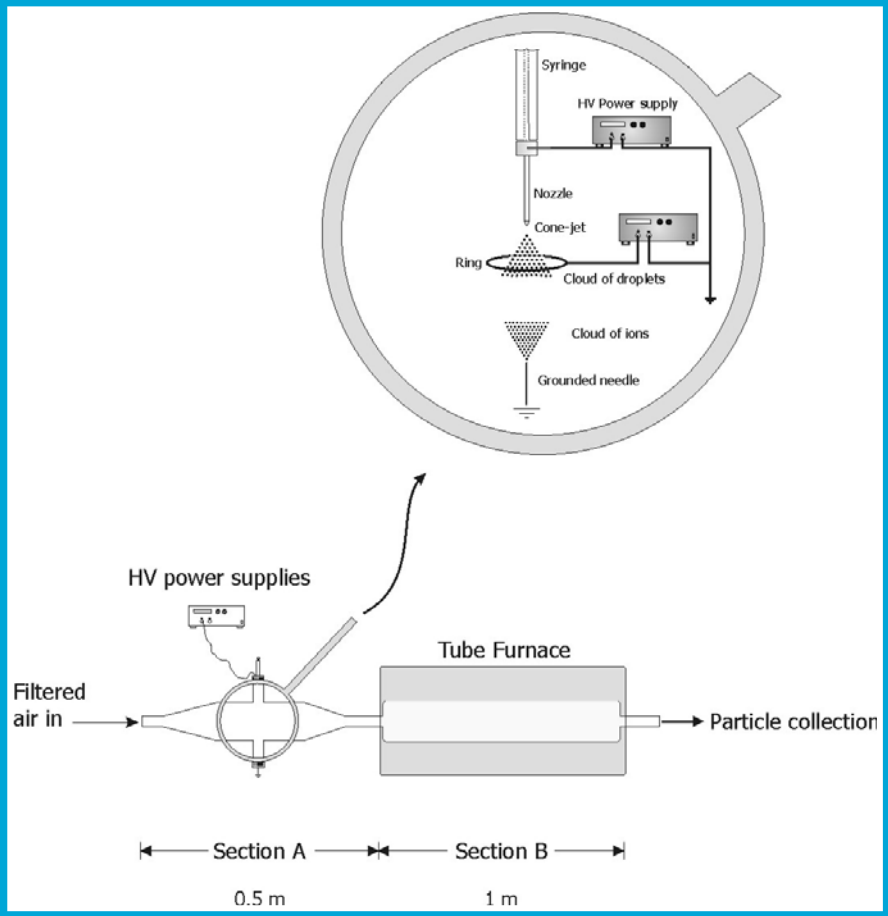
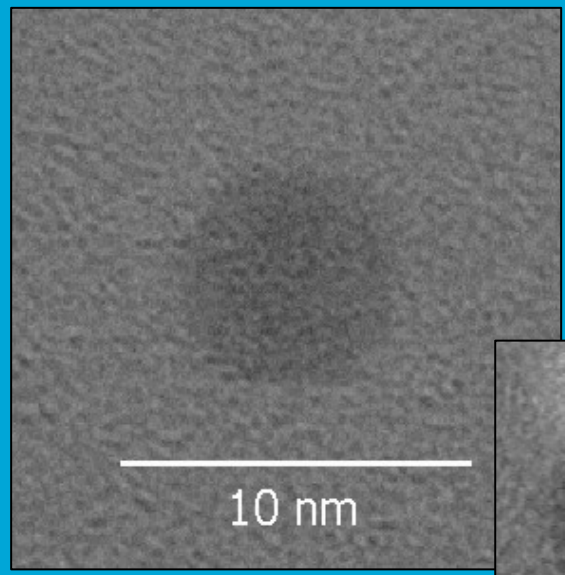
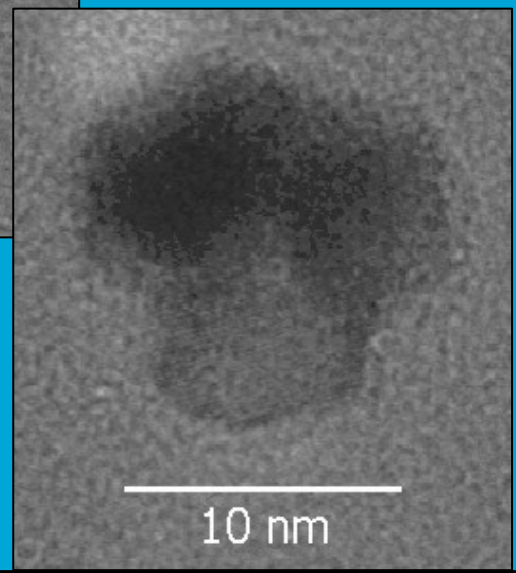
Pt nanoparticles aerosol reactor







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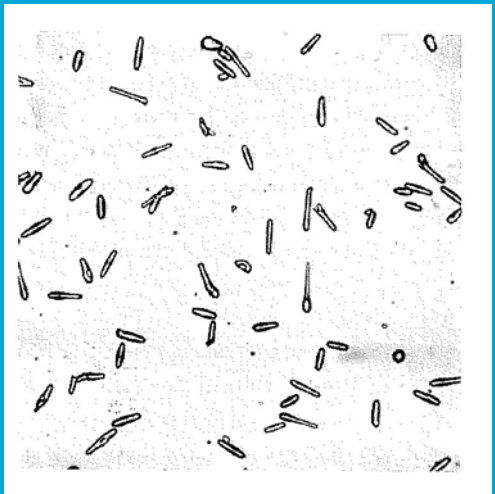
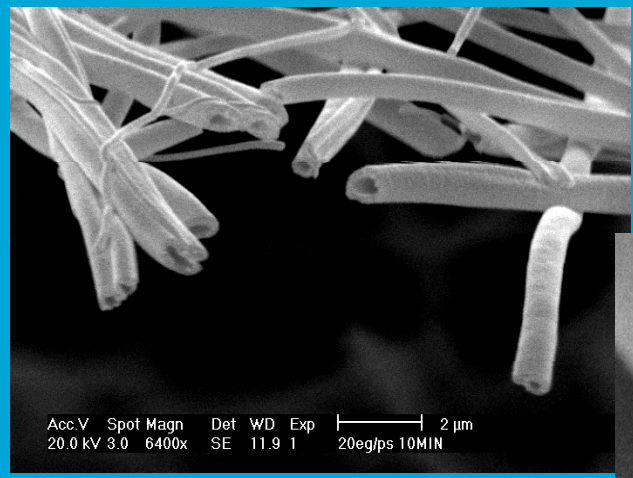
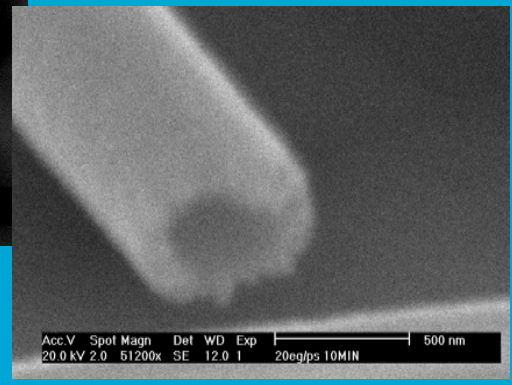
What about shapes?



Particles produced with the polymer, dichloromethane, acetone solution at a flow rate of 3ml/hr, with supply of an air flow

R. Hartman, PhD thesis, 1999





Electrospun nanotubes obtained from co-spinning olive oil / PVP-Ti(O_iPr)$_4$
A. Salvatella, MSc thesis, 2006

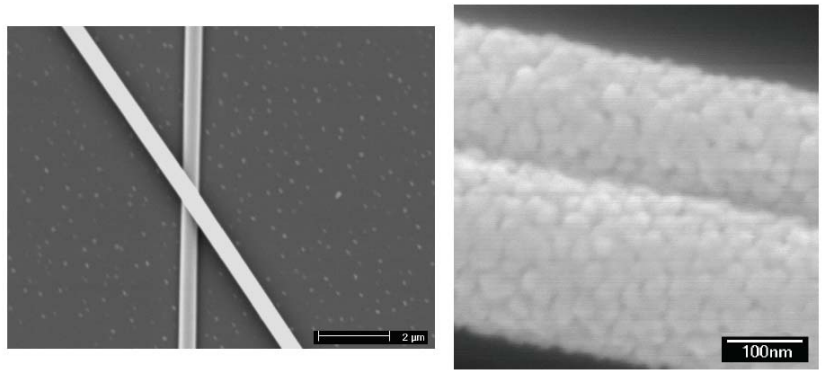


Figure 4.5a) smooth PVP nanofibers b) TiO_2 nanofibers close up after calcination

E.Herben, MSc thesis, 2006

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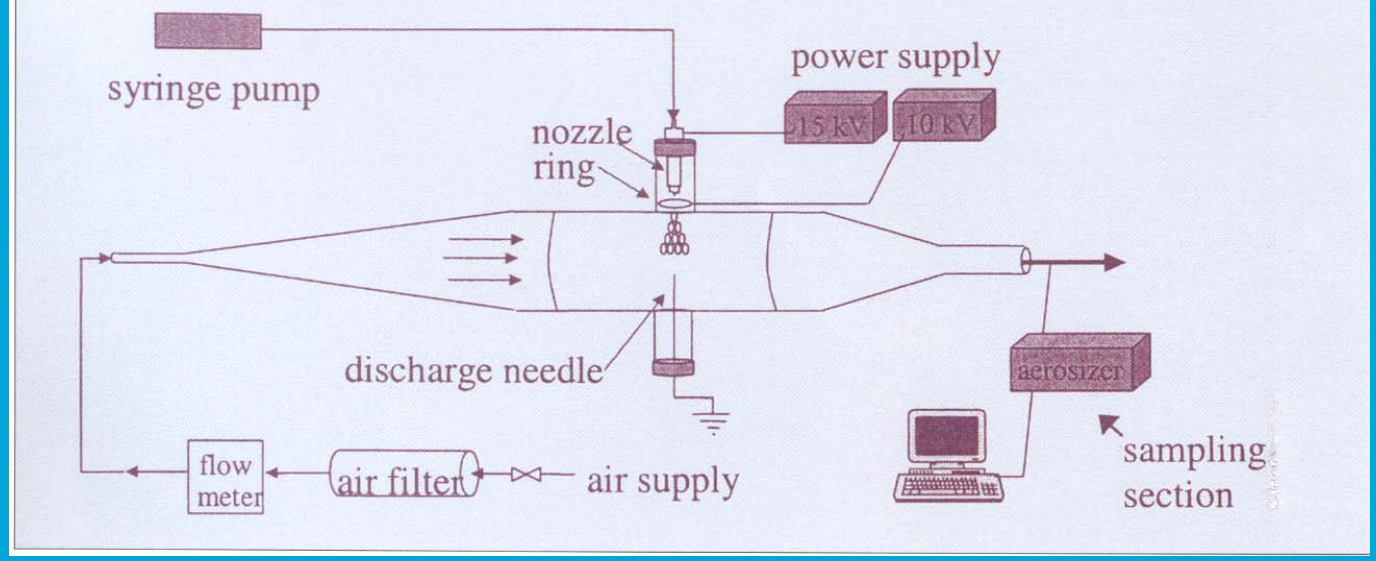
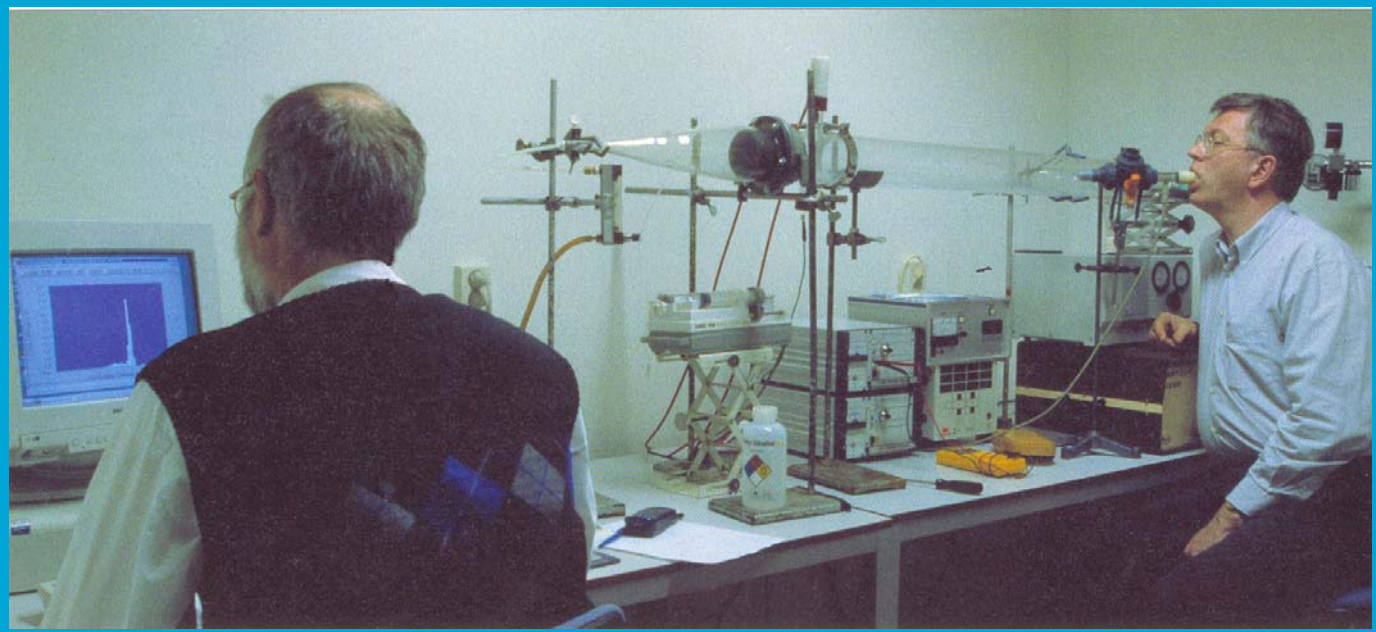

syringe pump
power supply
15 kV
10 kV
nozzle
ring
discharge needle
aerosizer
flow
meter
air filter
air supply
sampling
section



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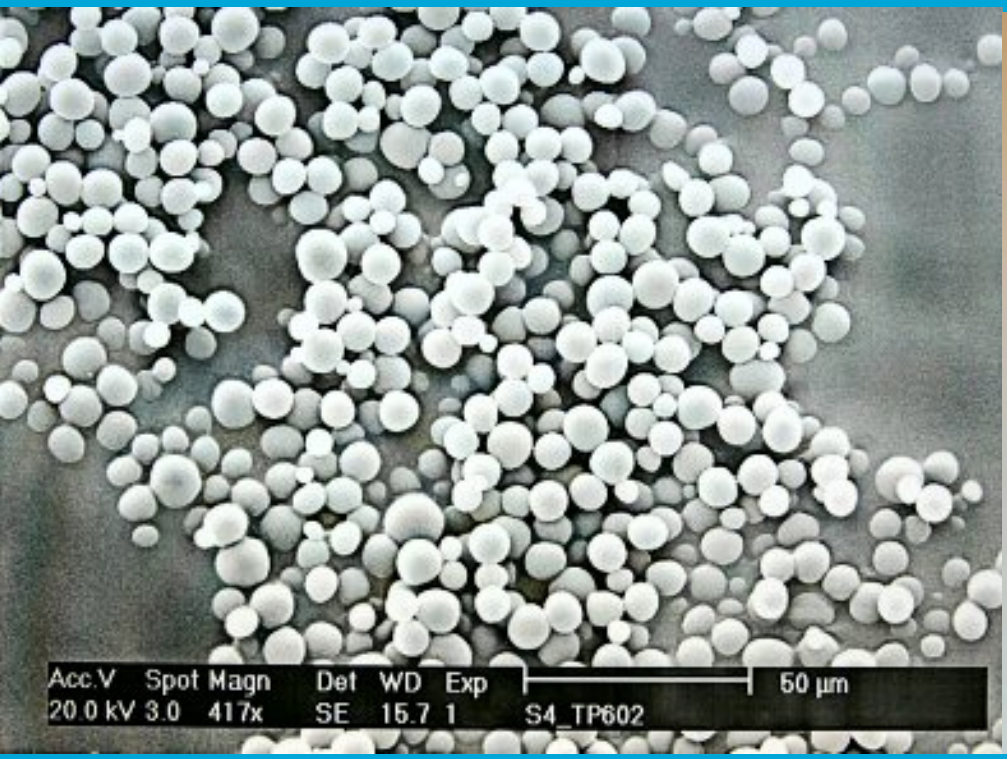

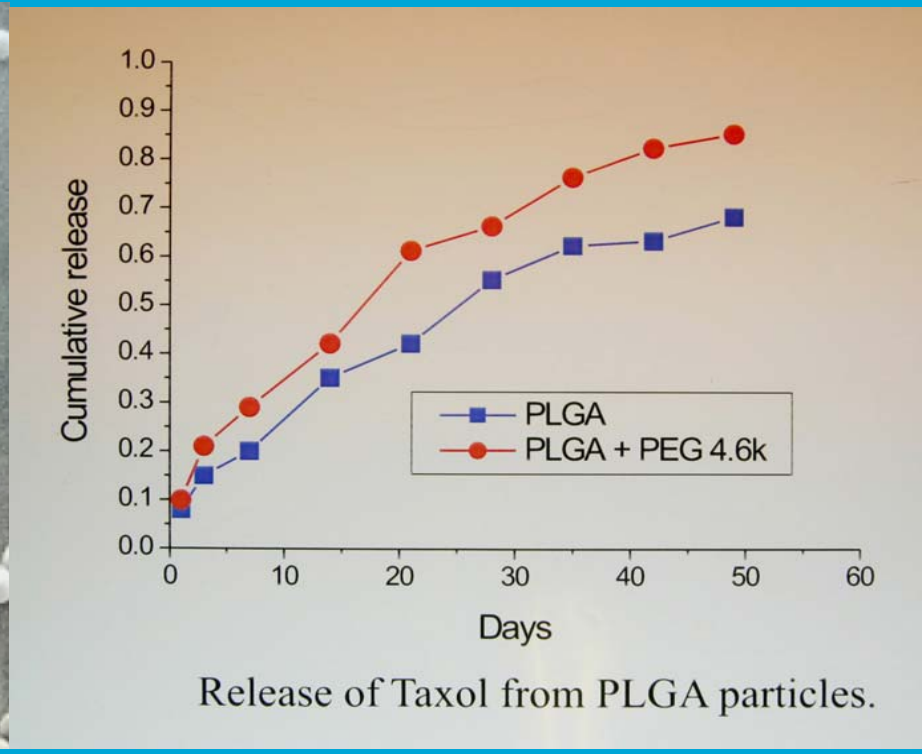

Release of Taxol from PLGA particles.

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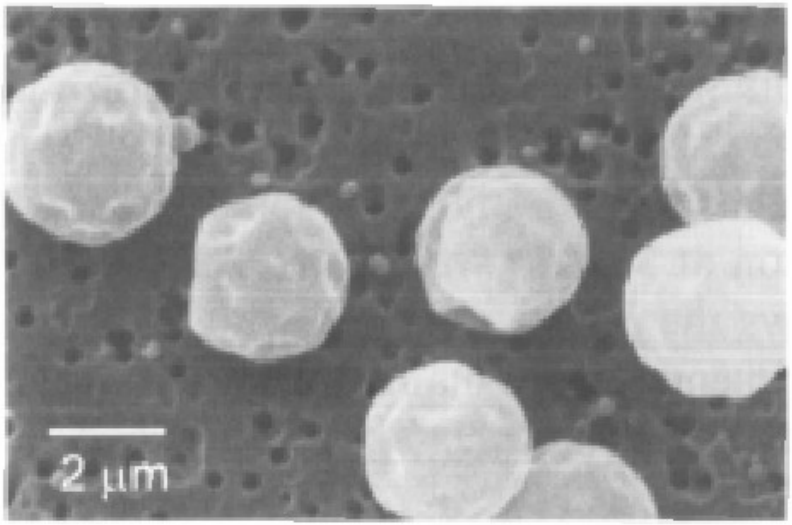

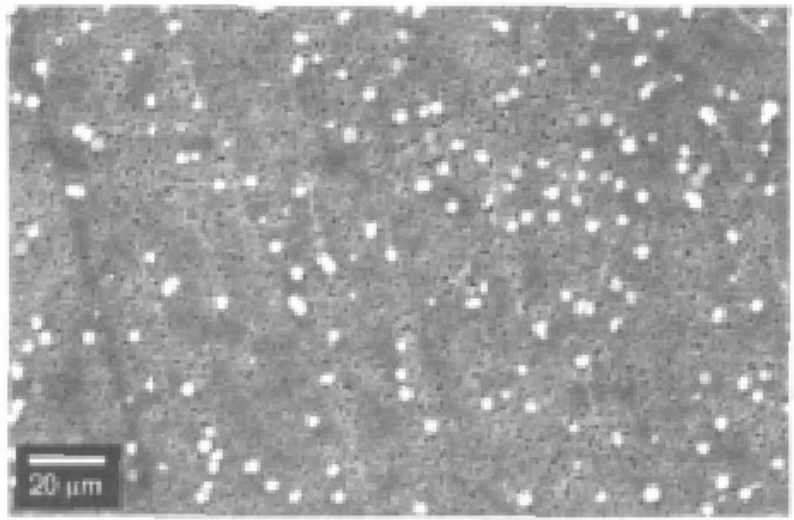

Figure 7. SEM pictures of medicine particles produced with electrospray.

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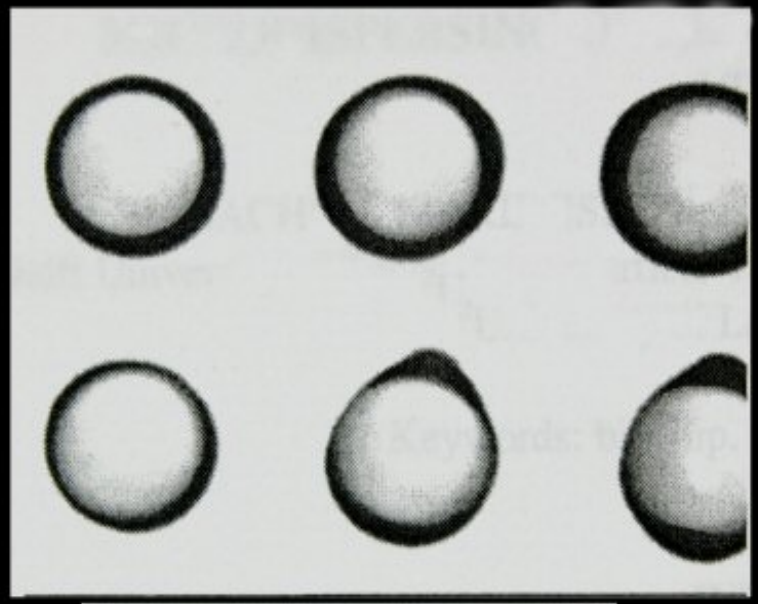

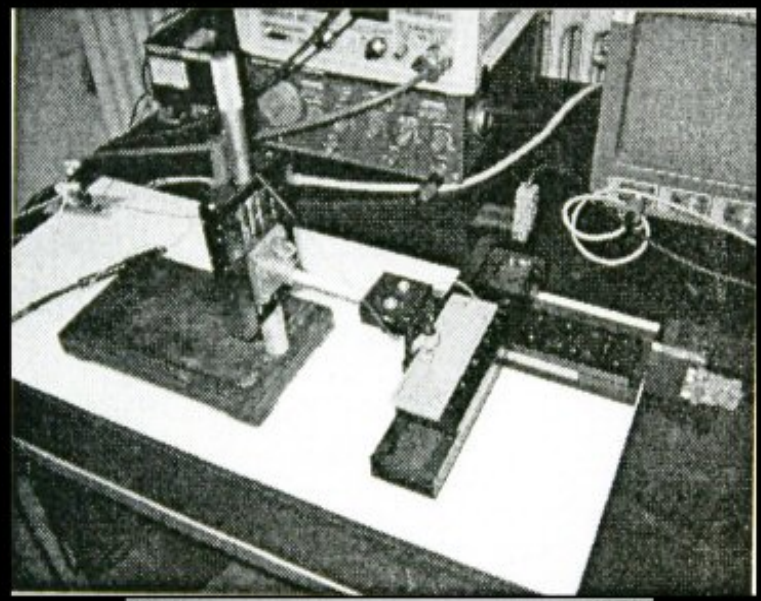

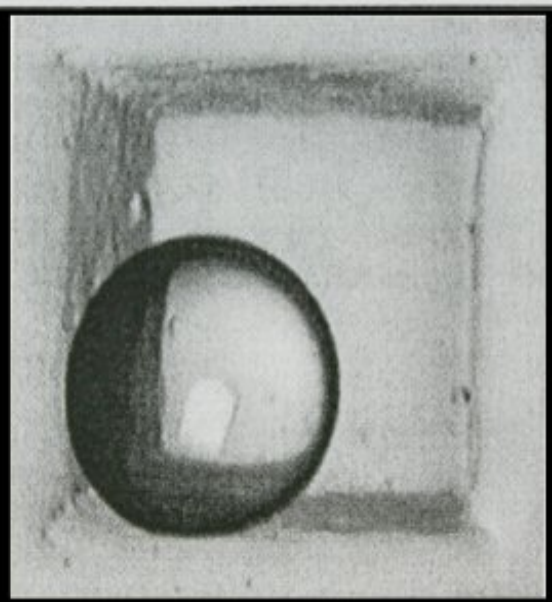

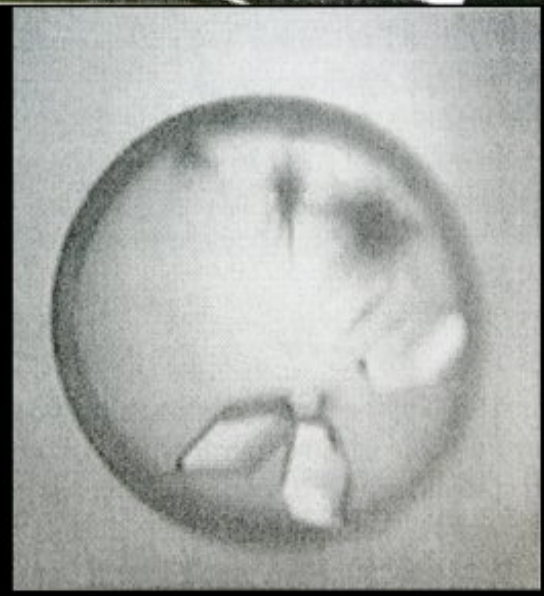

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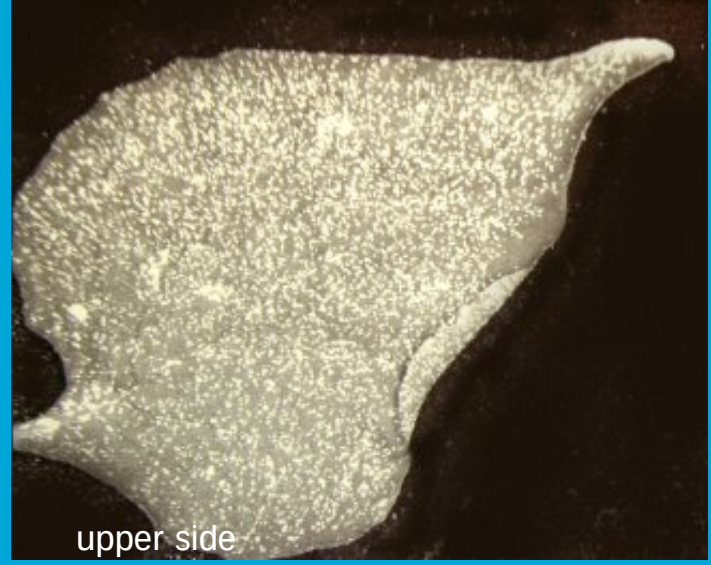

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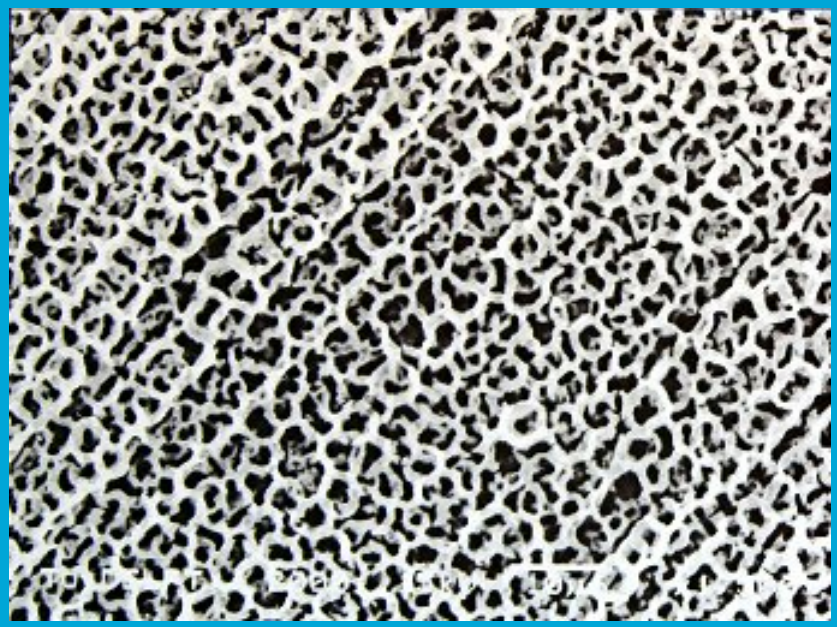
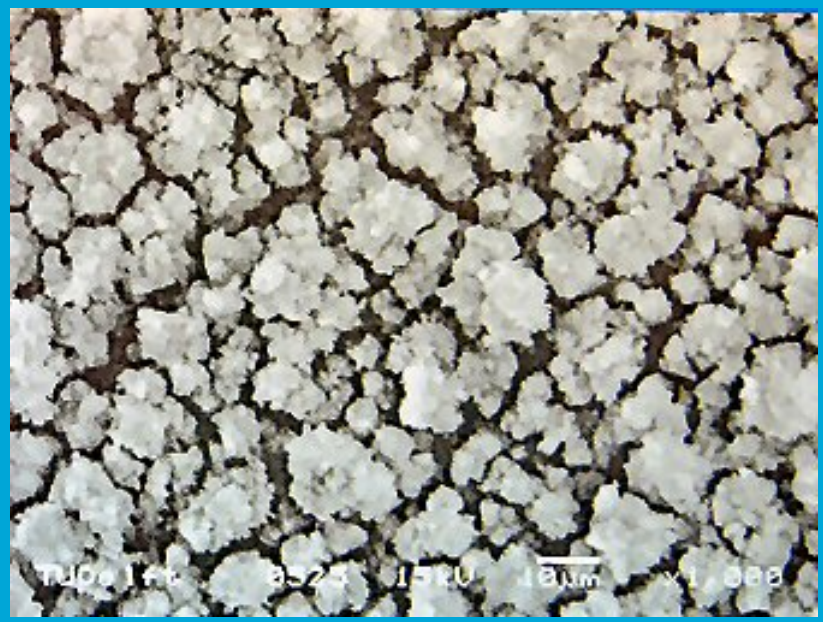
Thin layers





Sander Leeuwenburgh

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Natural, non-intentional and
intentional man made phenomena

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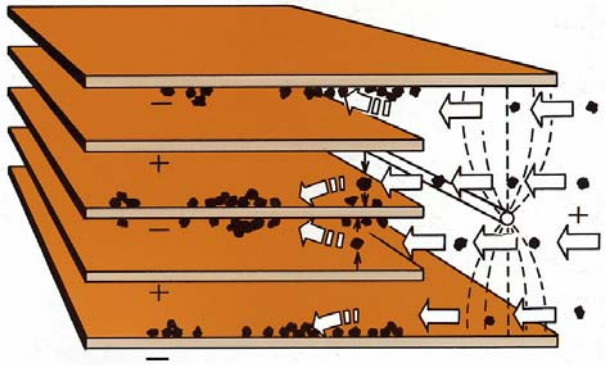

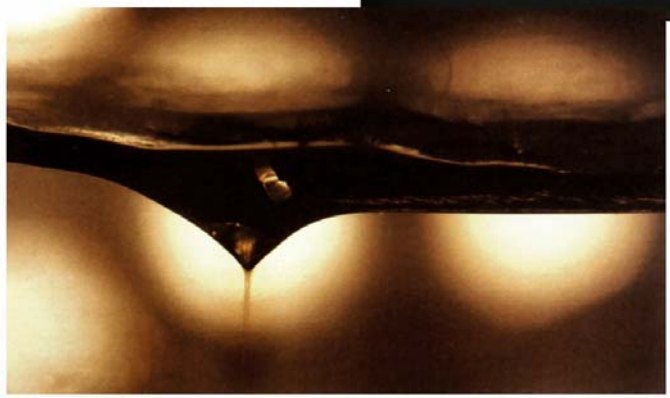

Photografics:
Philip Broos

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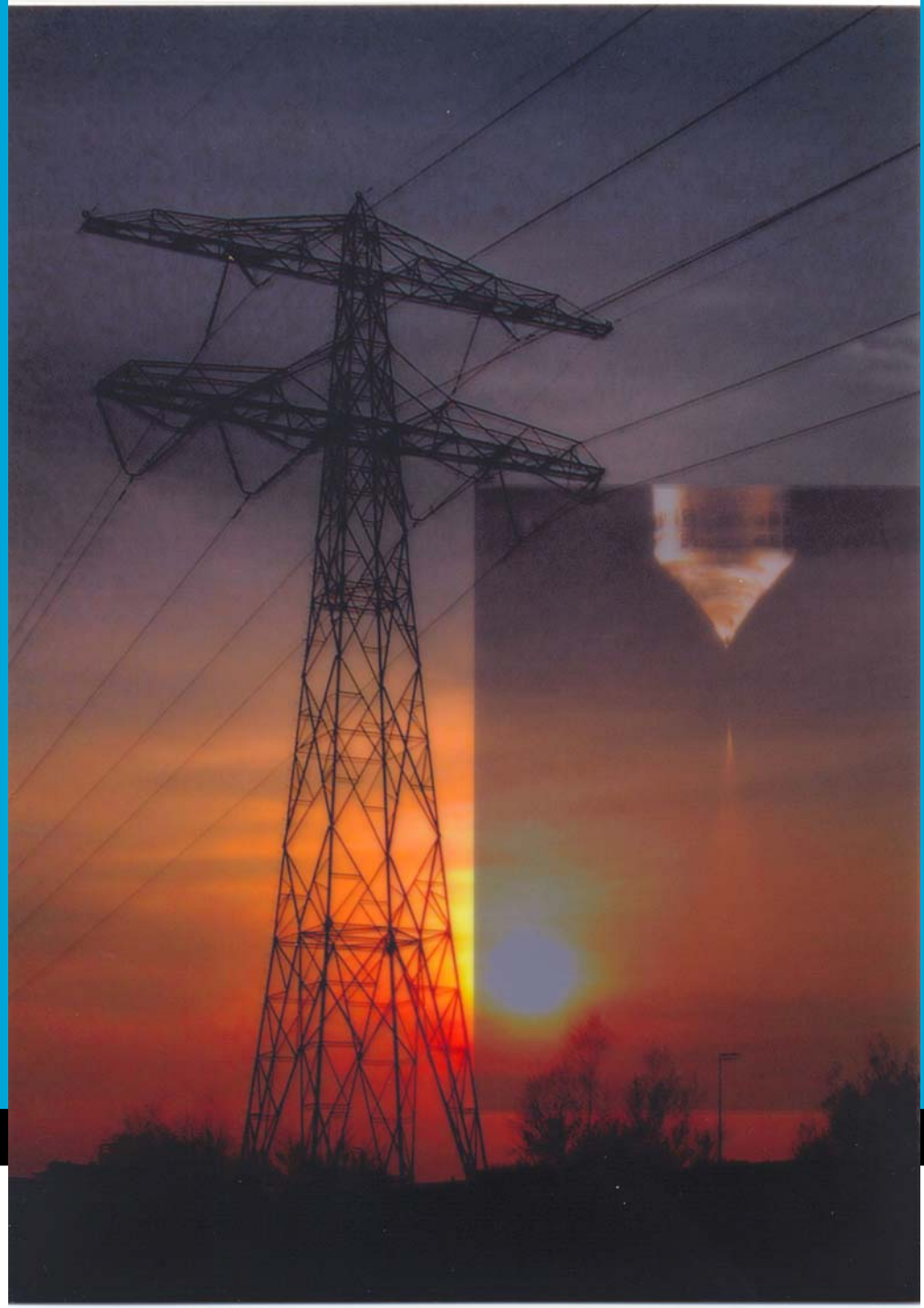

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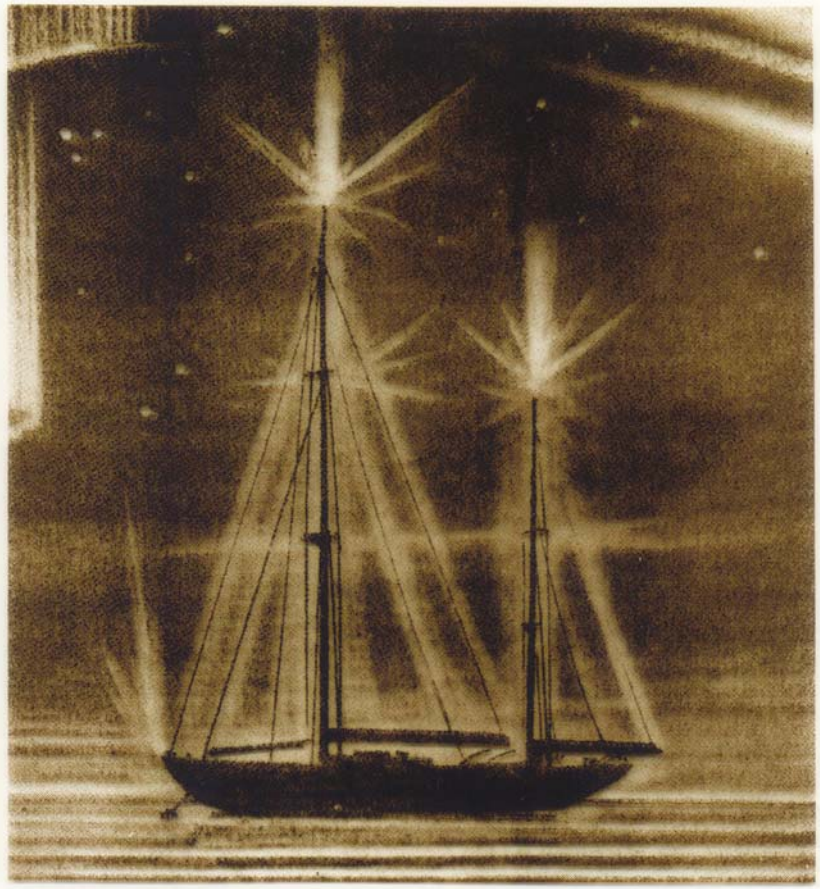

Cic. Why, saw you any thing more wonderful?
Casca. A common slave—you know him well by sight—
Held up his left hand, which did flame and burn
Like twenty torches join'd; and yet his hand,
Not sensible of fire, remain'd unscorch'd.
Besides,—I have not since put up my sword,—
Against the Capitol I met a lion,
Who glar'd upon me, and went surly by,
Without annoying me; and there were drawn
Upon a heap a hundred ghastly women,
Transformed with their fear, who swore they saw

Julius Caesar III.14-24
Shakespeare

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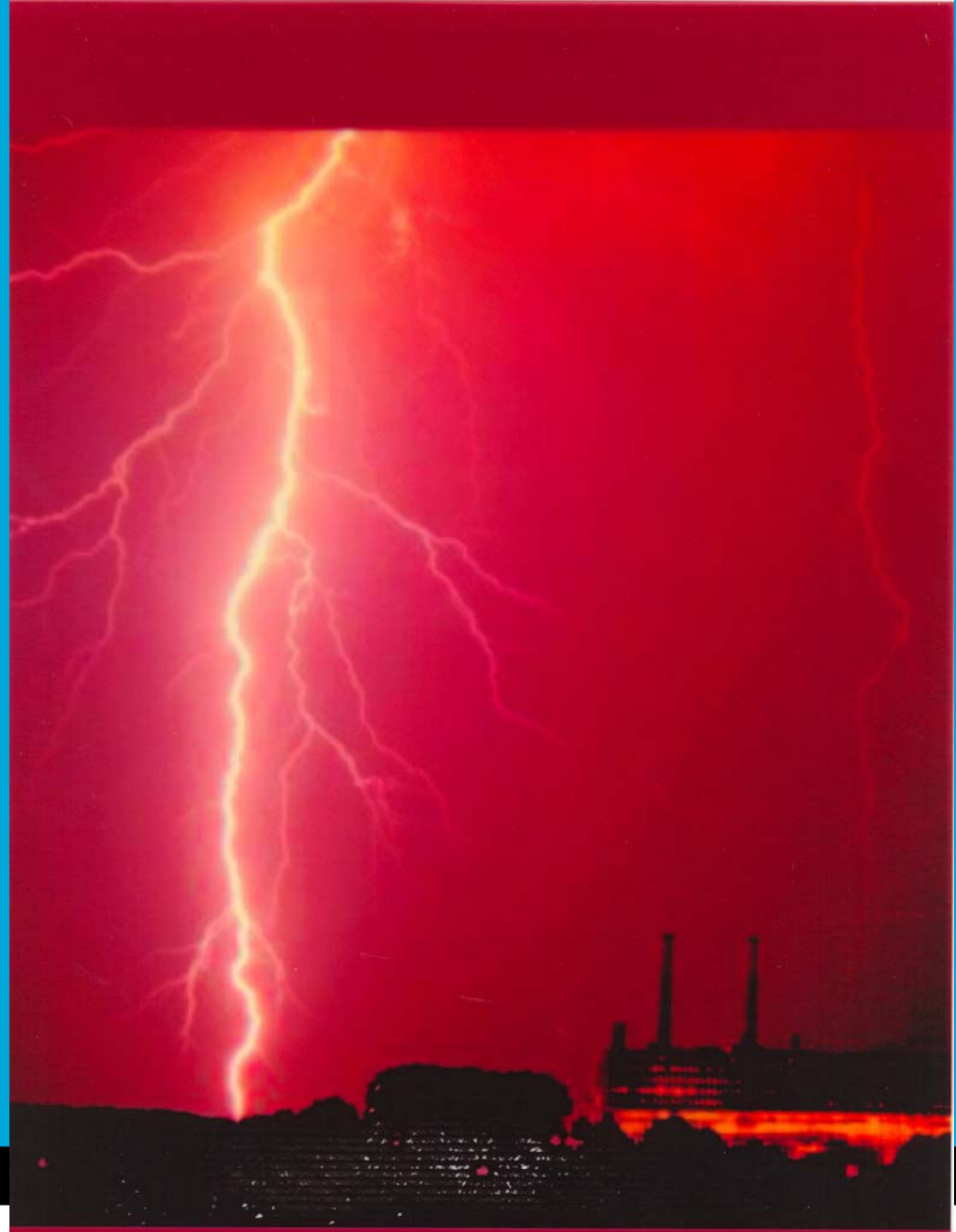

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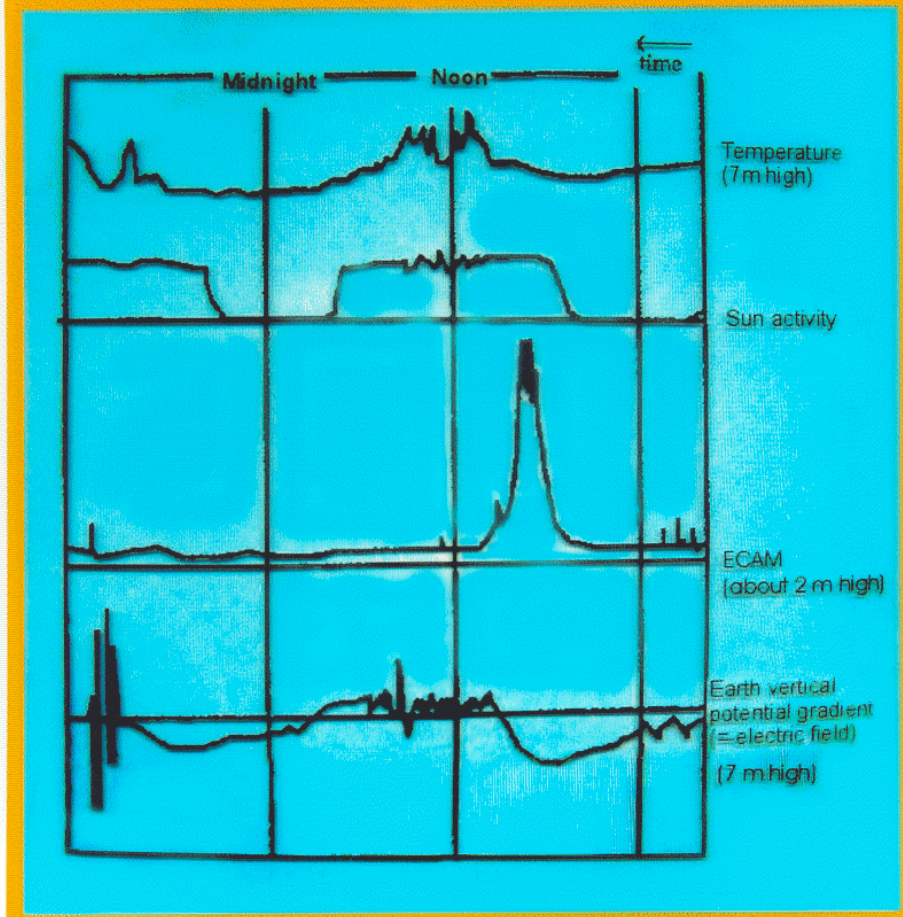
TEMPERATURE @ 7 m
SOLAR ACTIVITY



CHARGED AEROSOLS
ELECTRIC FIELD (VPG)

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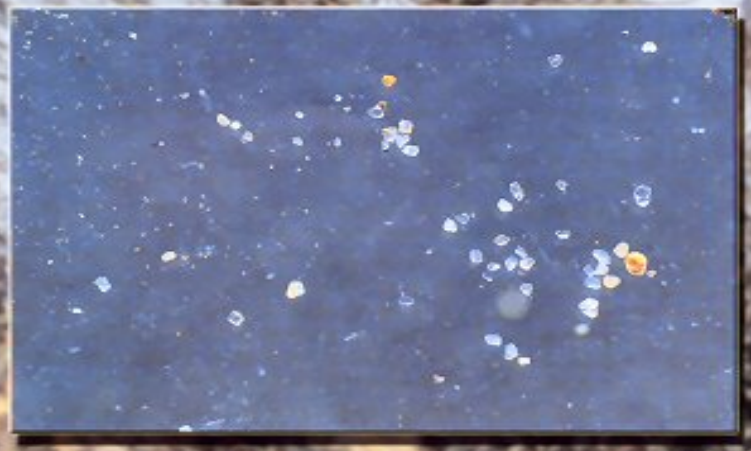

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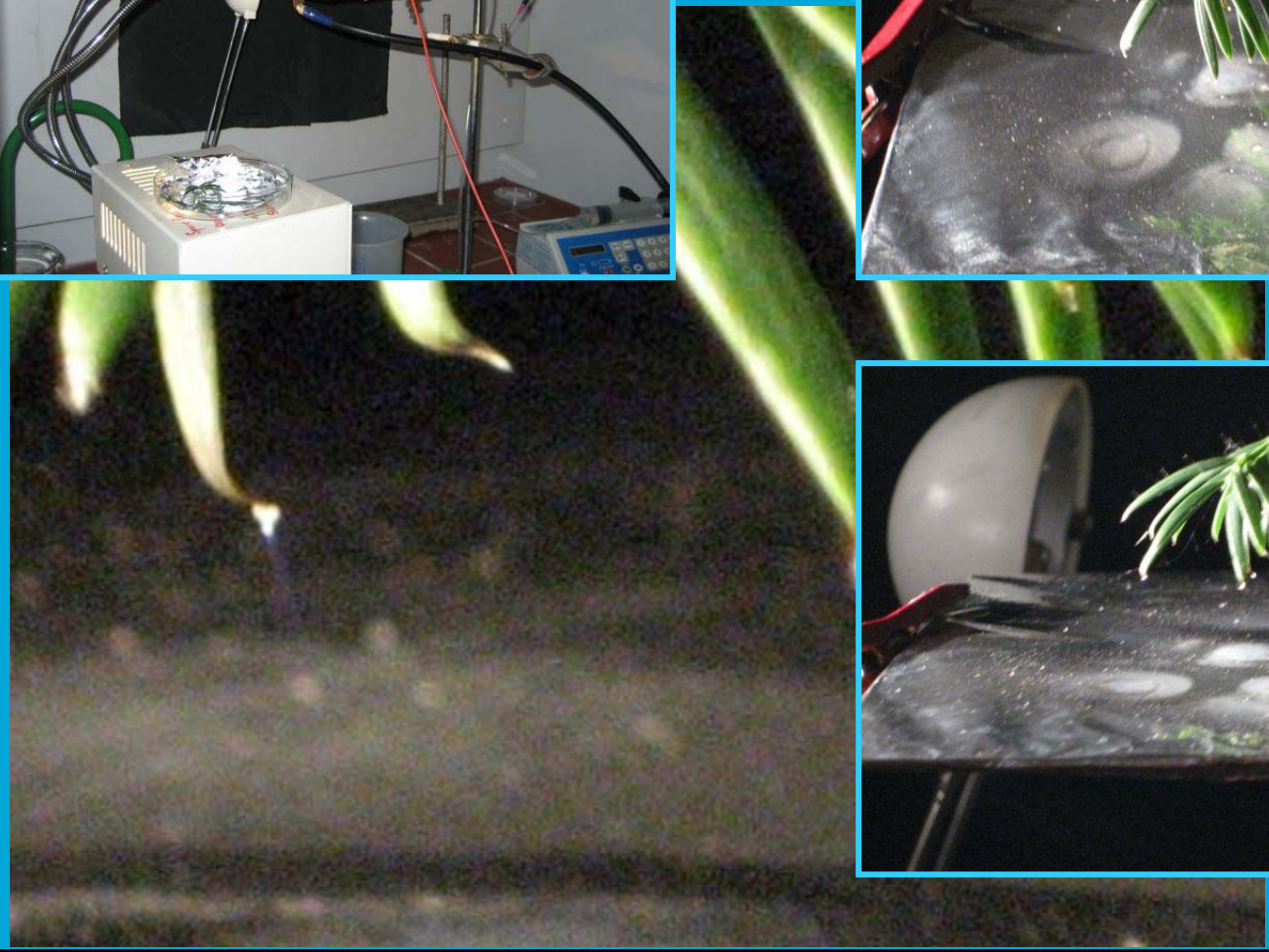

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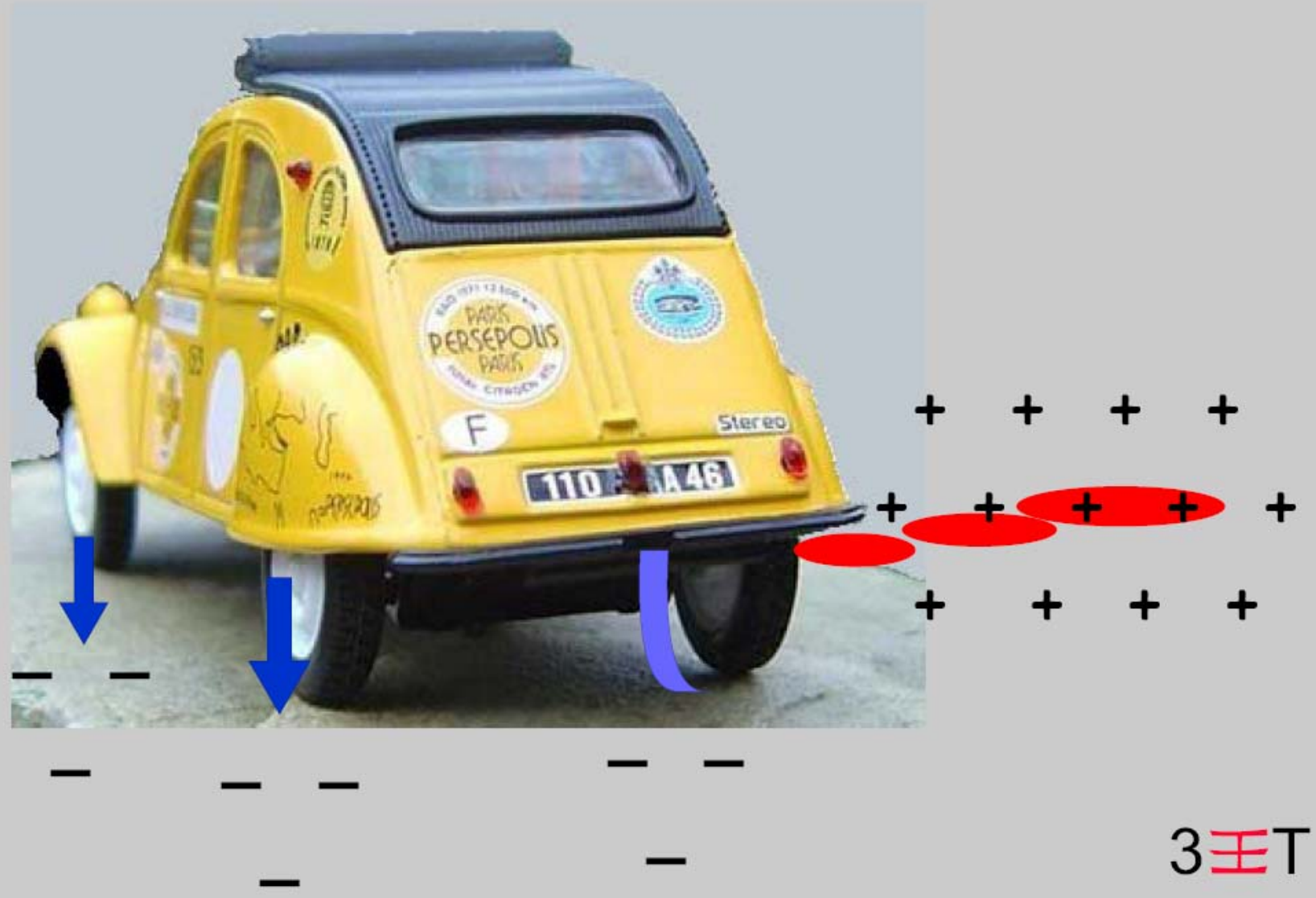
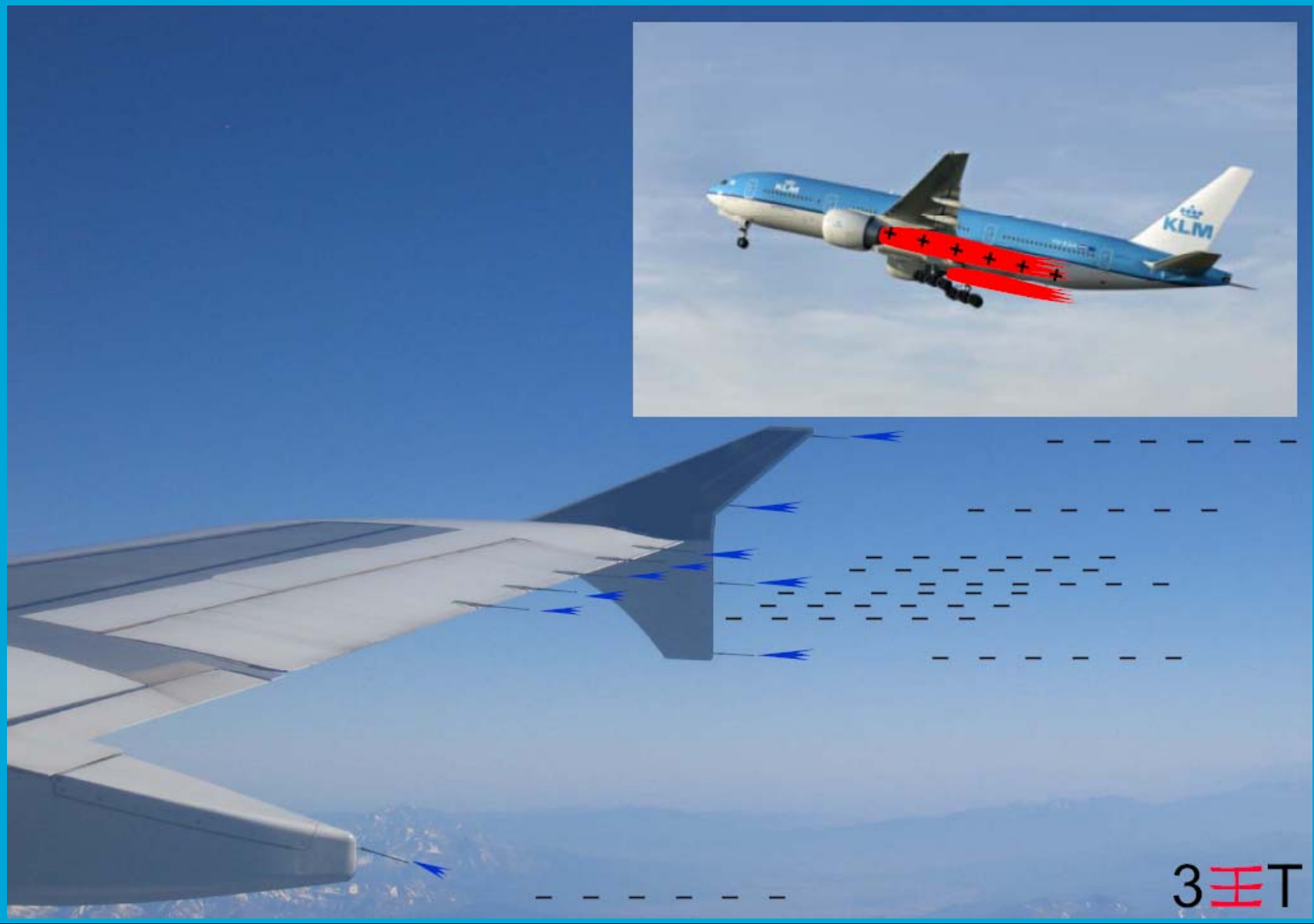

PARIS
PERSEPOLIS
PARIS
F
Stereo
110 A 46



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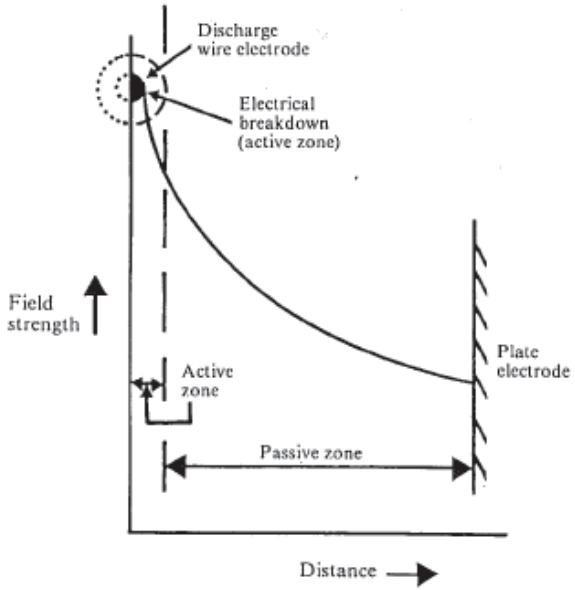

Figure 12.8 Plot of field strength as a function of distance from the discharge wire electrode for a corona discharge.

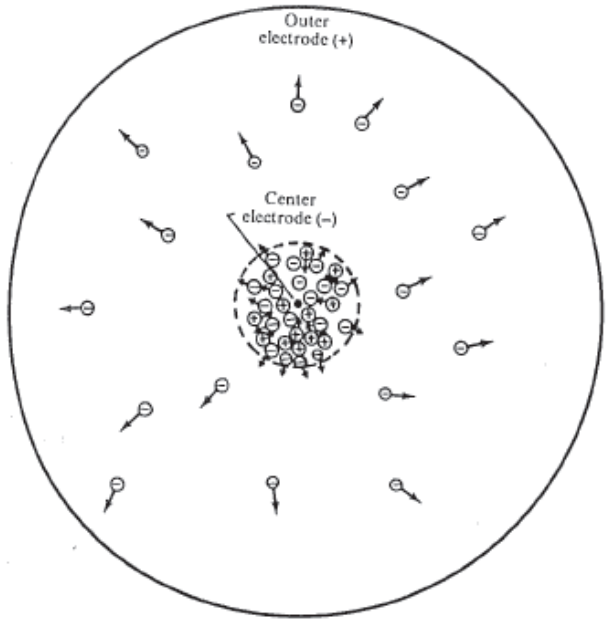

Figure 12.9 Schematic diagram of negative corona discharge showing negative ion motion away from center electrode, positive ion motion toward center electrode.

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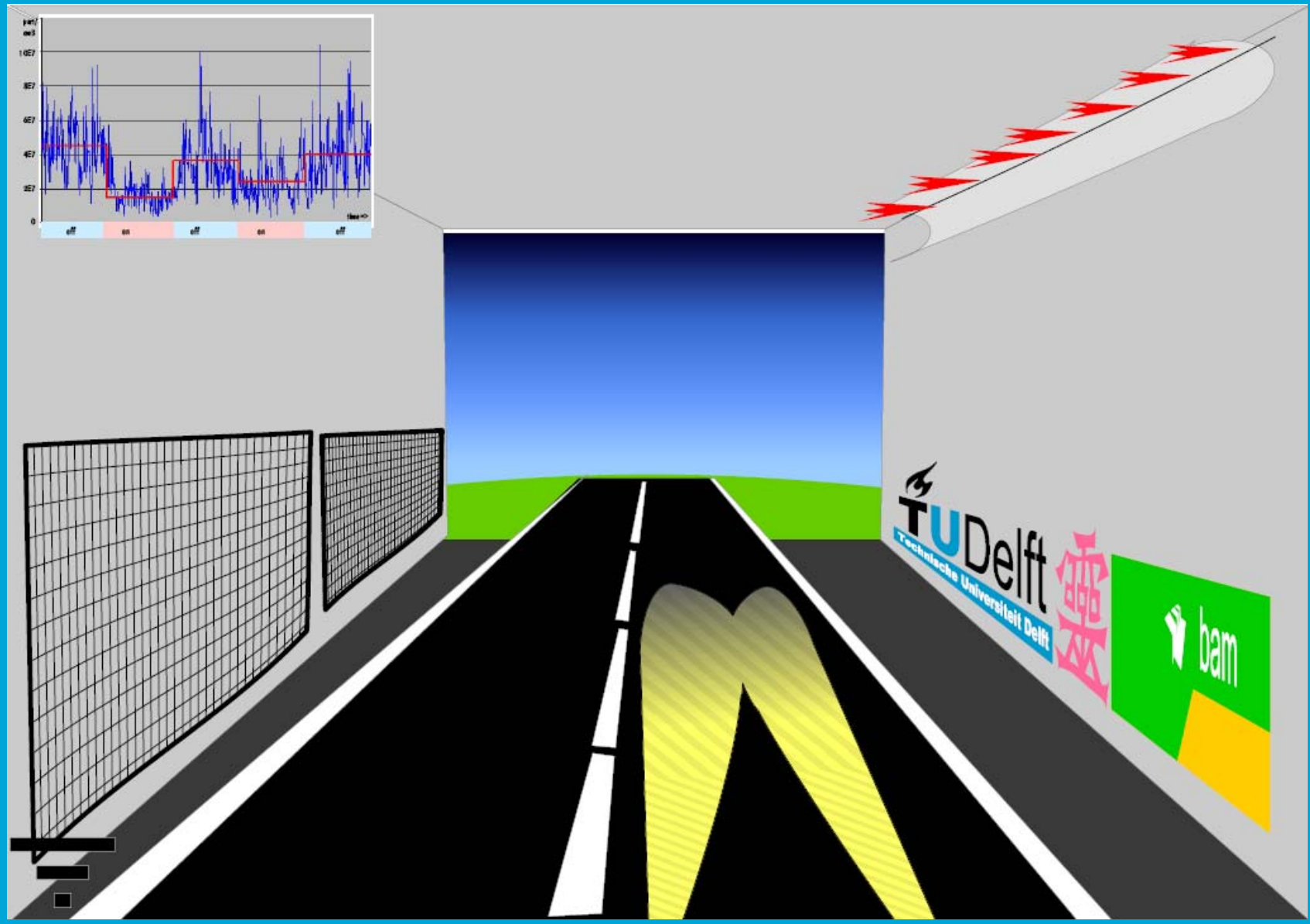

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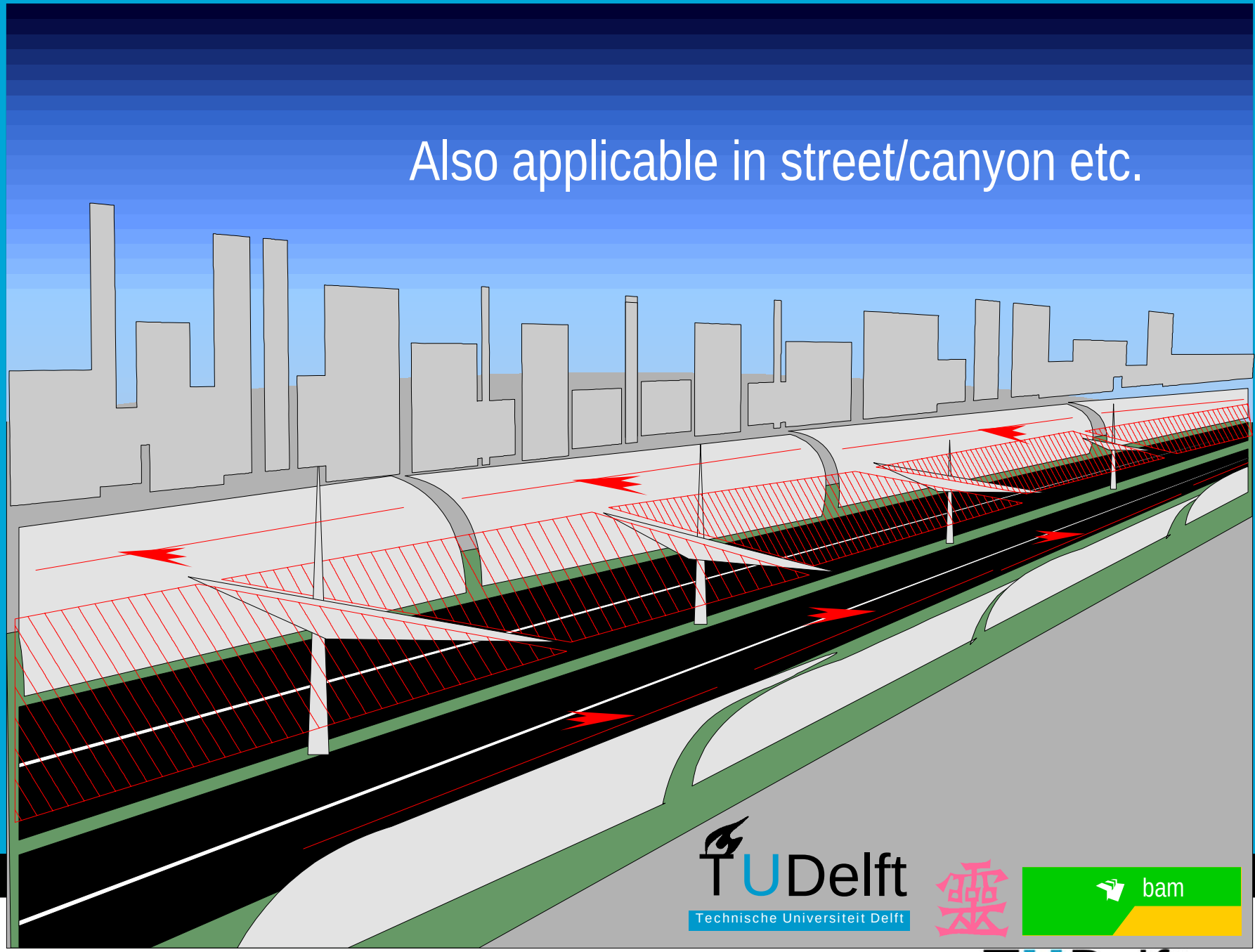
Formule 1	$N(t)/No = \exp [-V_{TE} t / H]$
Formule 2	$Z = ne C_c / 3 \pi \eta d$
Formule 3	$V_{TE} = ZE = ne E C_c / 3 \pi \eta d$

N(t)	= aantal deeltjes op tijdstip t per volume (concentratie)
No	= aantal deeltjes op tijdstip 0 per volume (concentratie)
V_{TE}	= de snelheid van de deeltjes
H	= afstand tussen coronabron en counterelectrode
Z	= elektrische mobiliteit
ne	= aantal elementaire ladingen

Also applicable in street/canyon etc.



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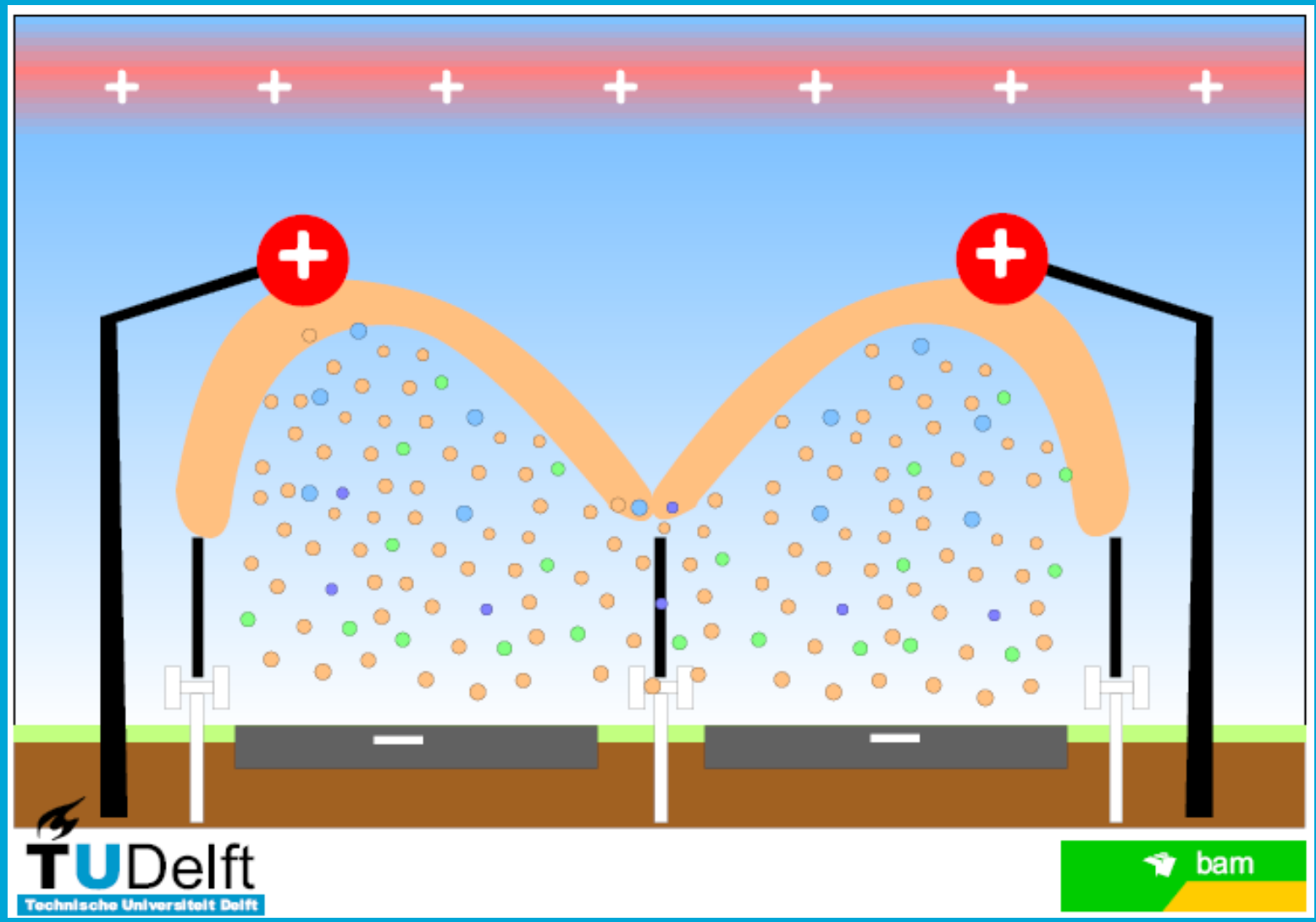
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