Since 1959

Can Microdroplets Make Soil?

A path to sustainable nanotechnology

Matter in confinement for sustainability

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InnoNano Research Pvt. Ltd.
InnoDI Water Technologies Pvt. Ltd.
VayuJAL Technologies Pvt. Ltd.
Aqueasy Innovations Pvt. Ltd.
Hydromaterials Pvt. Ltd.
EyeNetAqua Pvt. Ltd.
Deepspectrum Analytics Pvt. Ltd.

Professor-in-charge

International Centre for Clean Water

TRIPS 2025, IIT Madras, August 23, 2025

Ashutosh Sharma

Practicing Attached Detachment

Science

A scale of 100 0

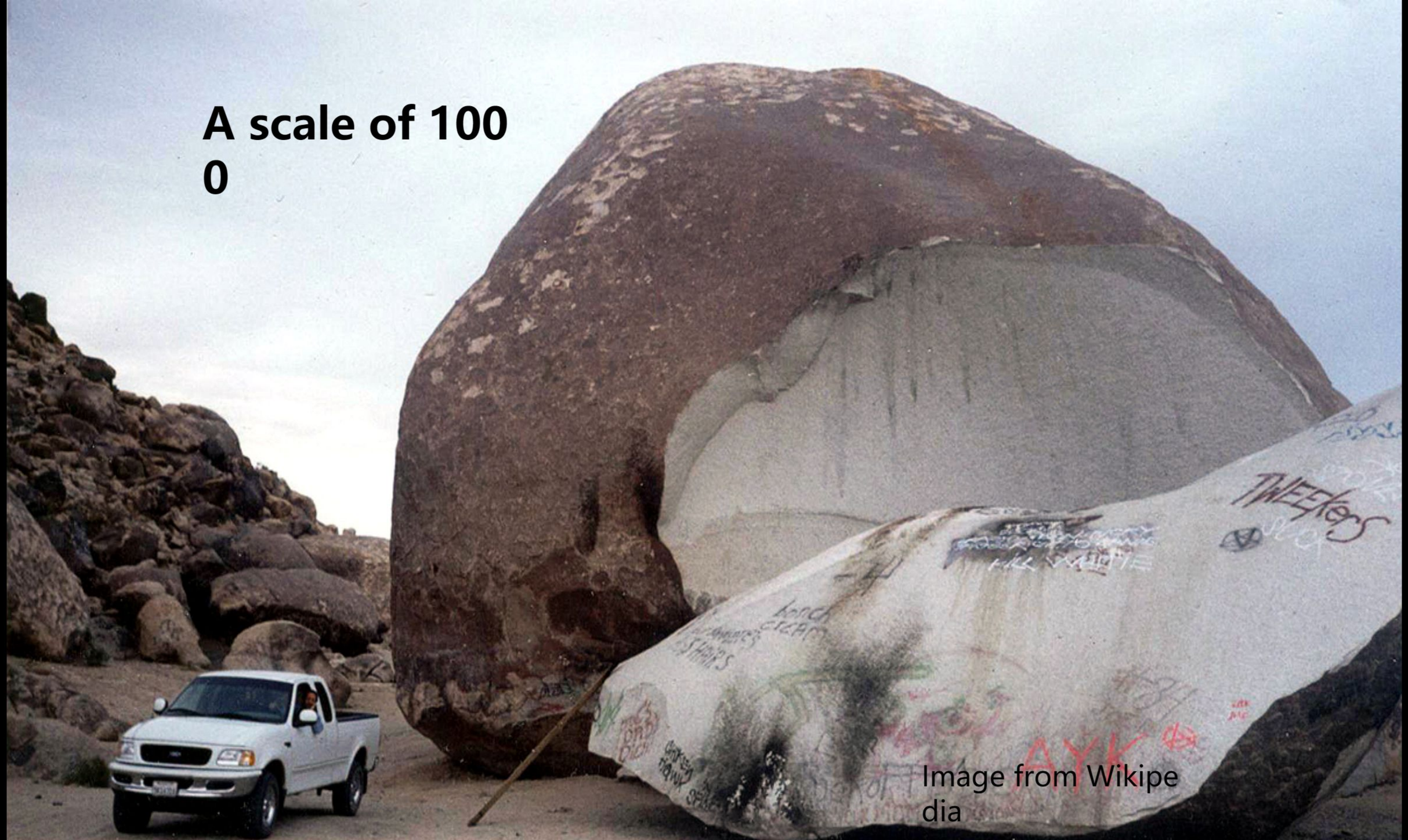
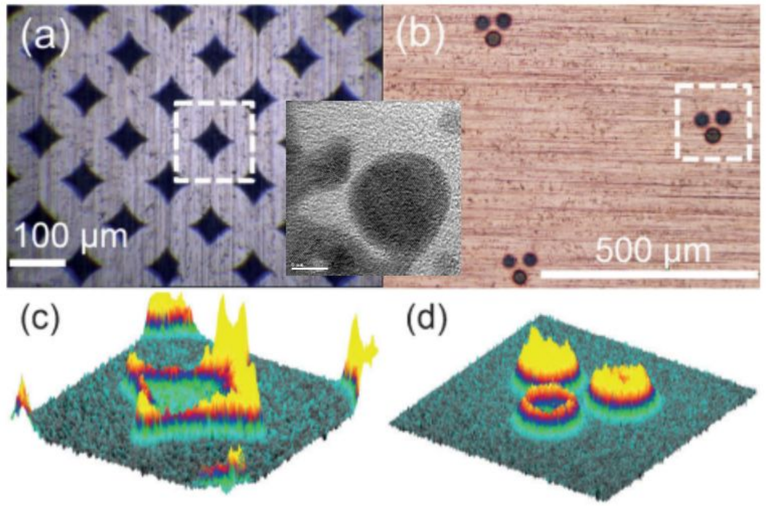


Image from Wikipedia

Functional Nanomaterials



Anyin Li, et. al., Angew. Chem. Int. Ed. 2014, 53, 12528 –12531.

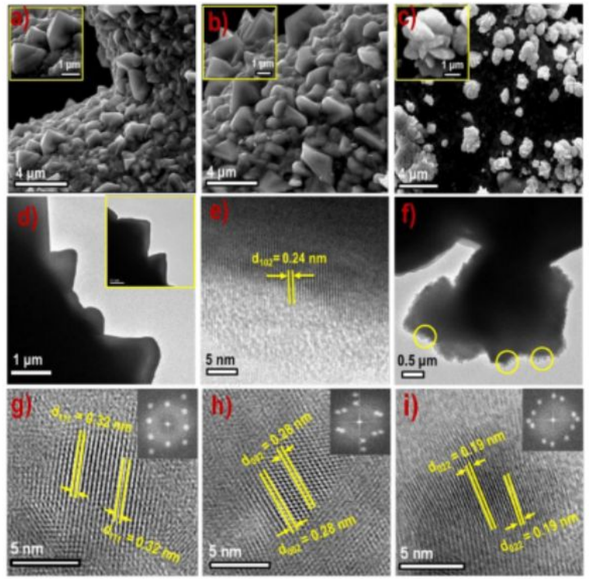
0 D

1 D

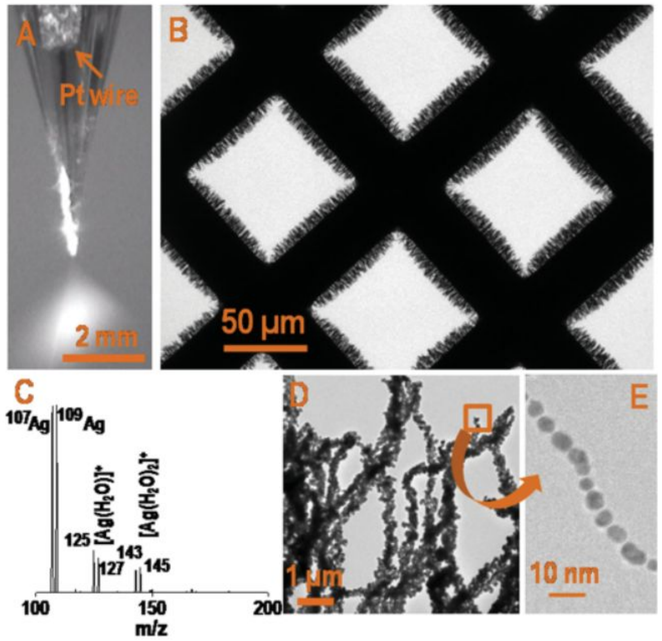
Microdroplets

3 D

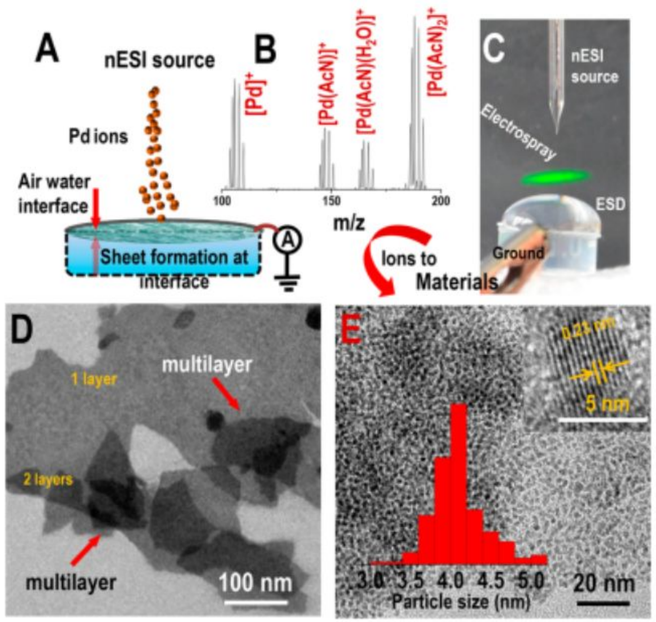
2 D



Arijit Jana et. al., *J. Mater. Chem. A,* 2019, 7, 6387–6394.



Depanjan Sarkar et. al., *Adv. Mater.* 2016, 28, 2223–2228.



Depanjan Sarkar, et. al., *J. Phys. Chem. C* 2018, 122, 17777−17783.

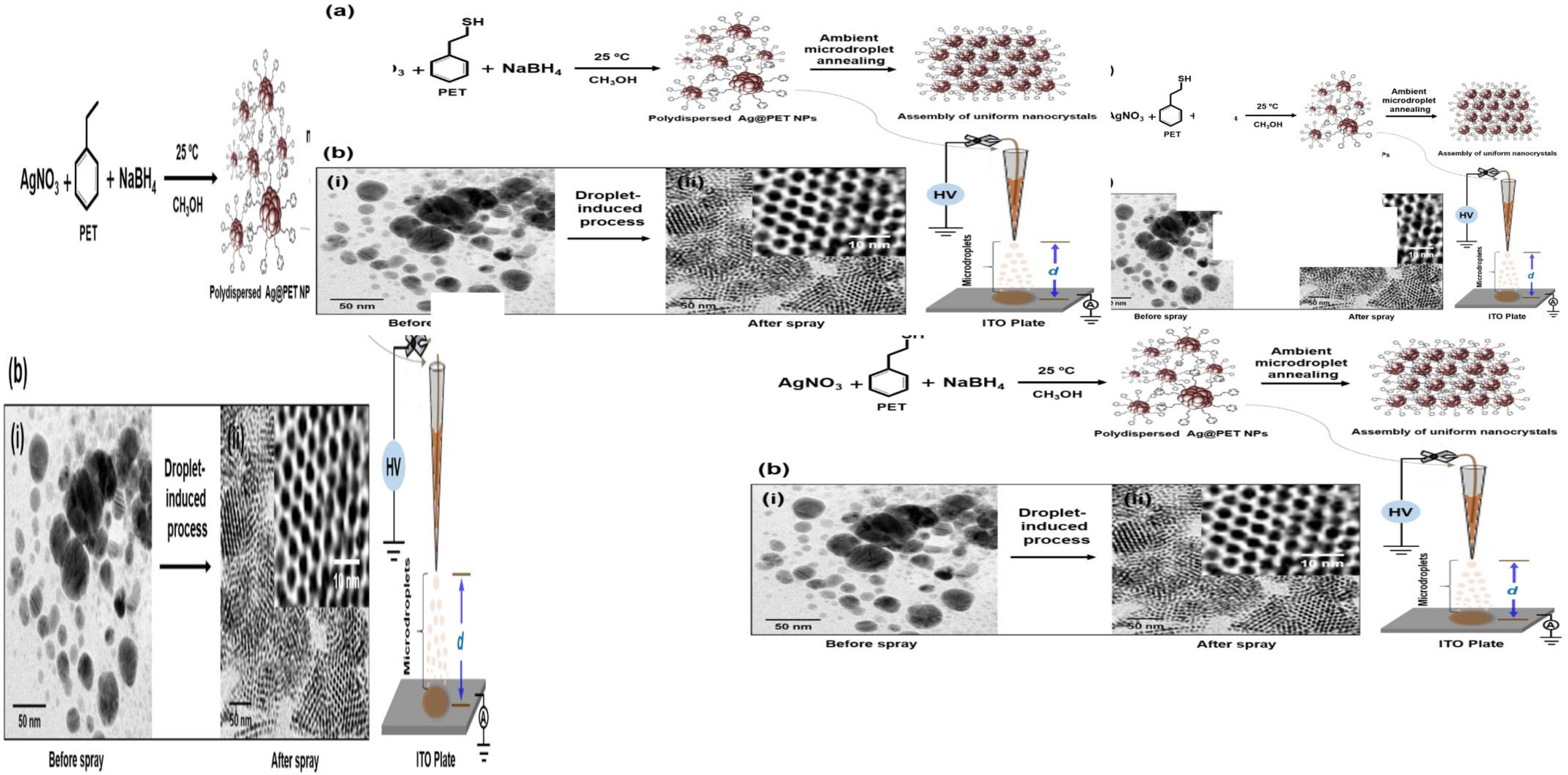
Understanding Microdroplets

Pallab Basuri et. al. *Chem. Sci.,* 2022, 13, 13321–13329.

Transformation of Materials in Microdrop lets

Ambient Microdroplet Annealing of Nanoparticles

Synthesis of polydisperse NPs



Angshuman Ray Chowdhuri et. al., *Chem. Sci.*, 2021, 12, 6370–6377.


Thanks to ChatGP
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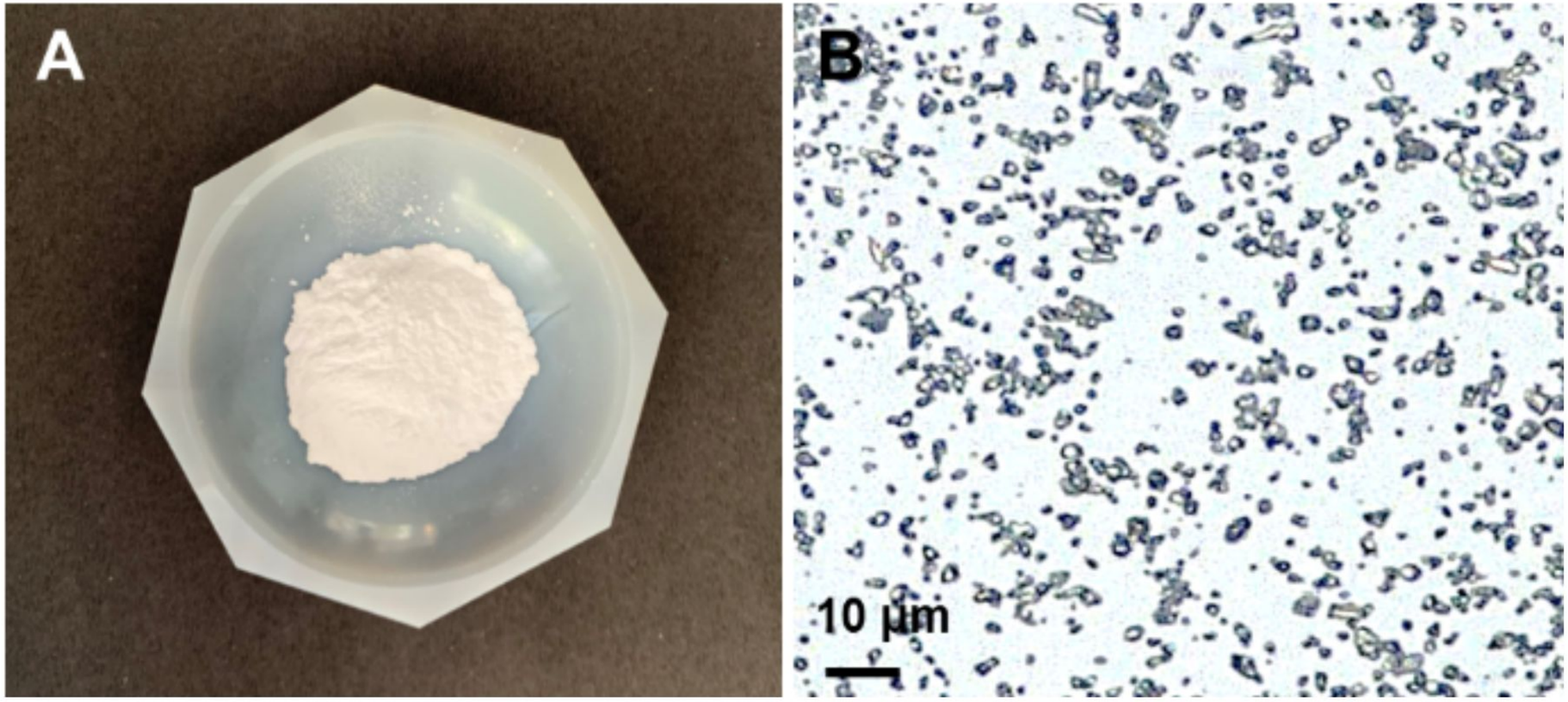
Weathering in Nature

Sand, the Ubiquitous Material

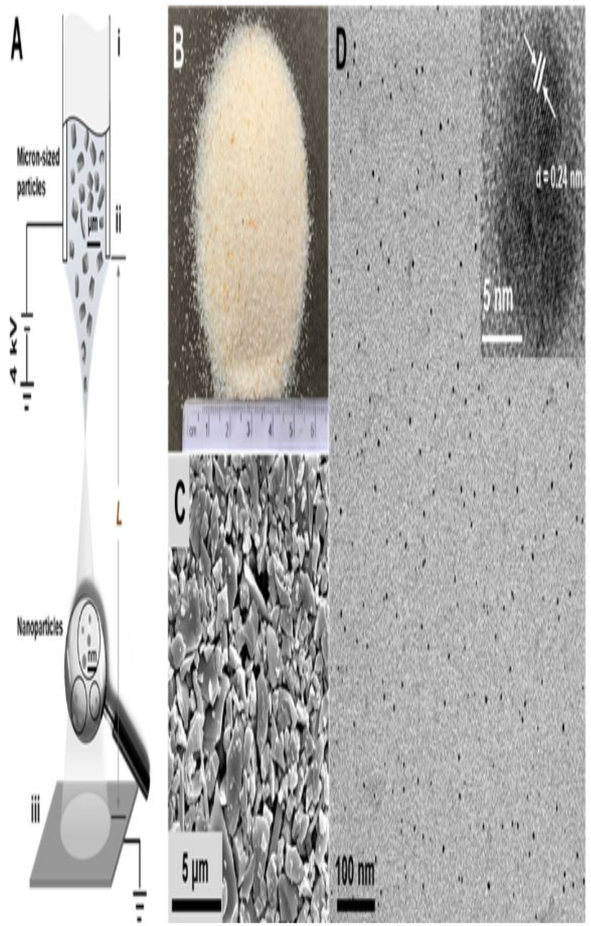
Images from Wikipe
dia

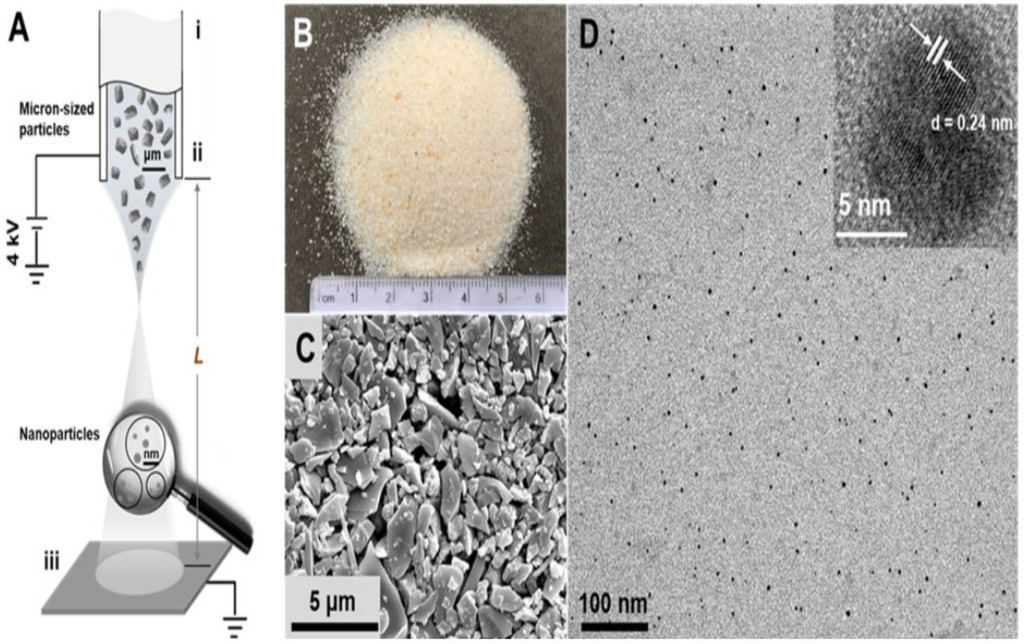


Ground silica

Optical image of silica

Weathering of Minerals in Microdroplets

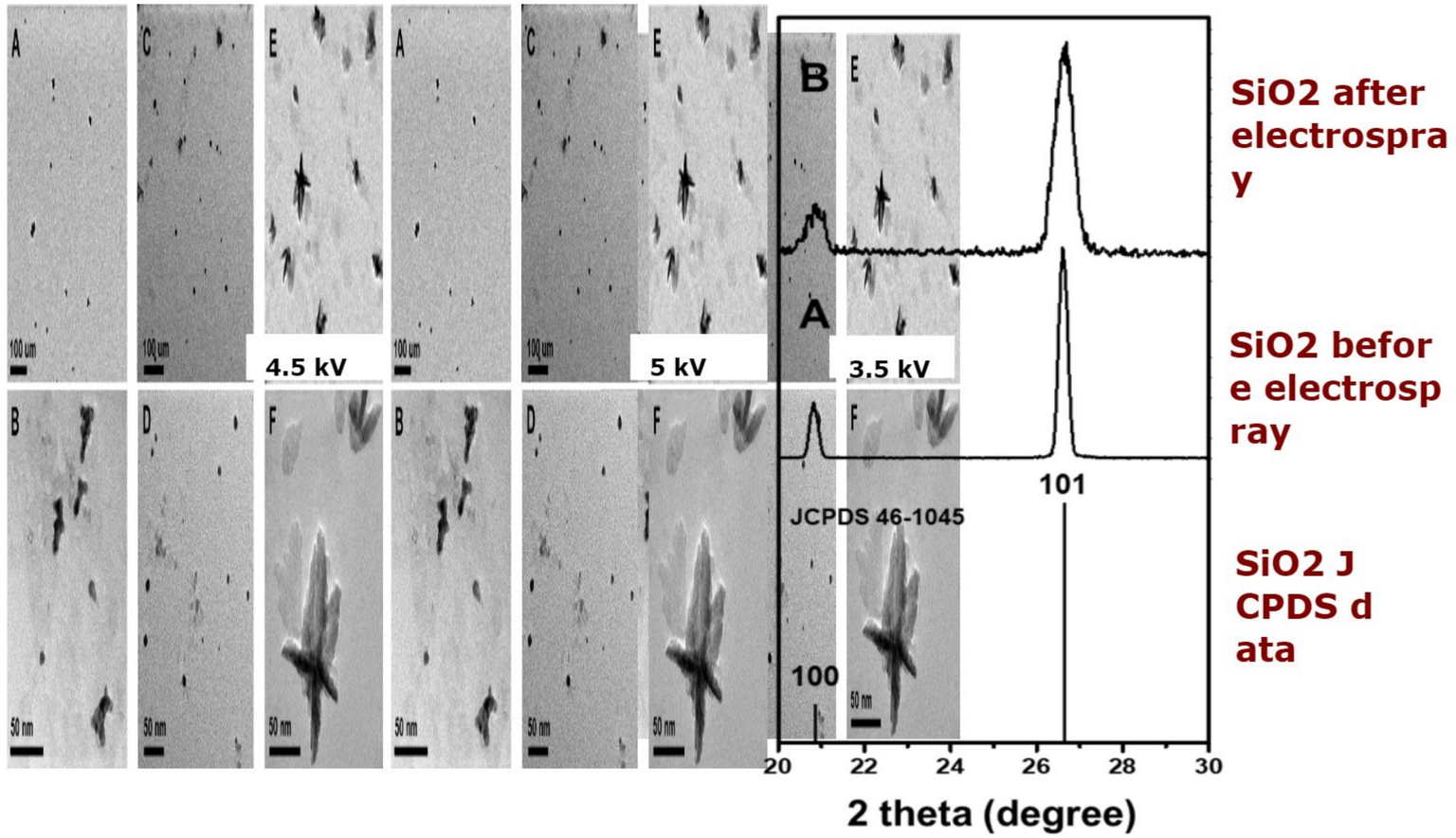




Spoorthi, et. al., *Science*, 2024

Ruby, Fused Alumin
a

Fragmentation of Silica – Varying Conditions



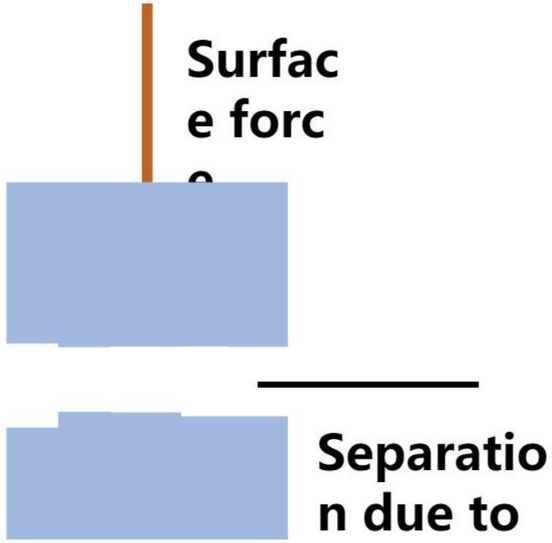
SiO2 after electrospray

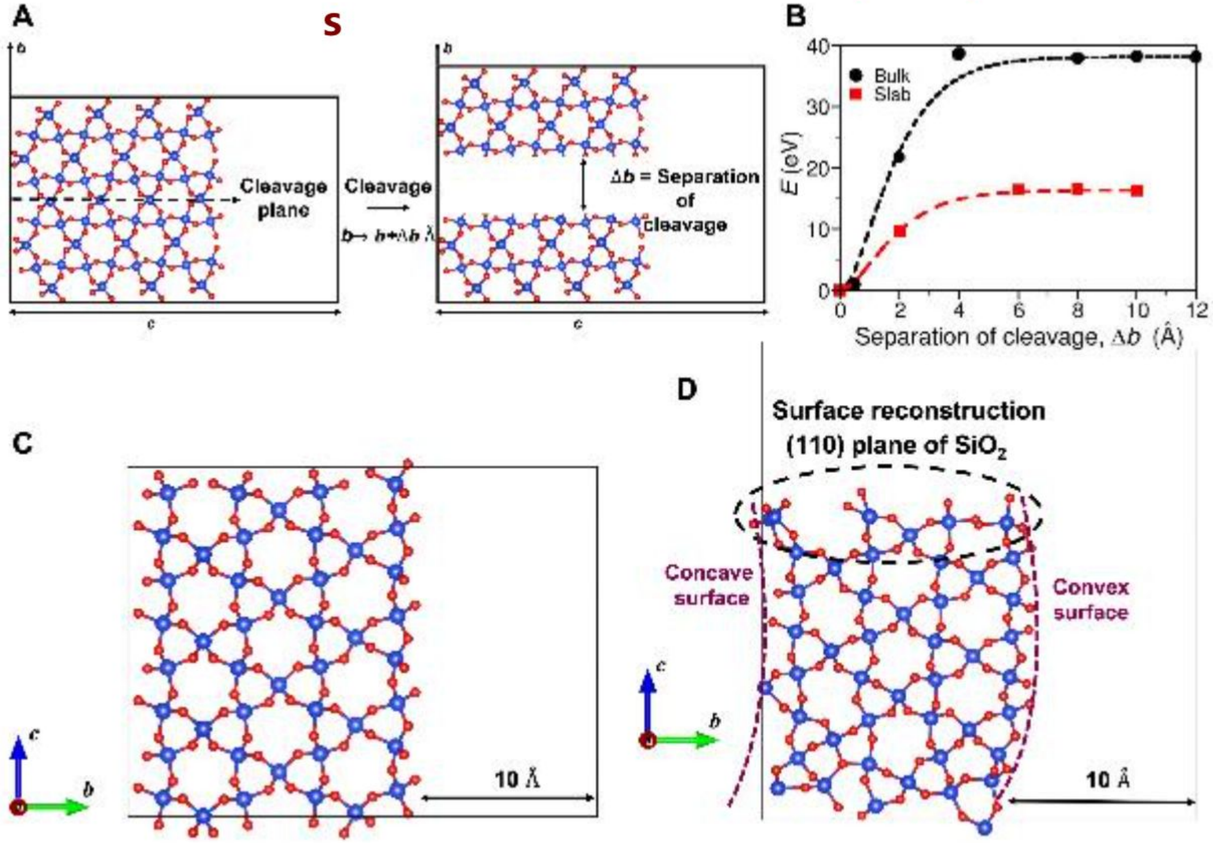
SiO2 before electrospray

SiO2 JCPDS data

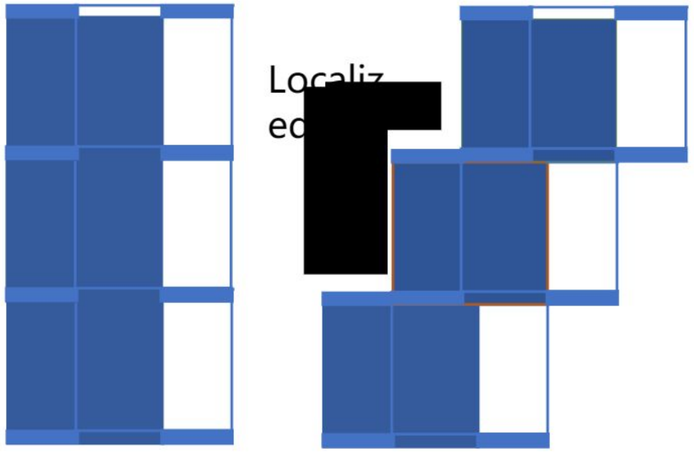
Mechanism: Cleavage

The process of cleavage and surface reconstruction visualized with first-principles simulation





Mechanism: Slip



This instability leads to the formation of a sta cking fault on the (010) plane, achieved with slip localized at (010) plane

Stacking fault

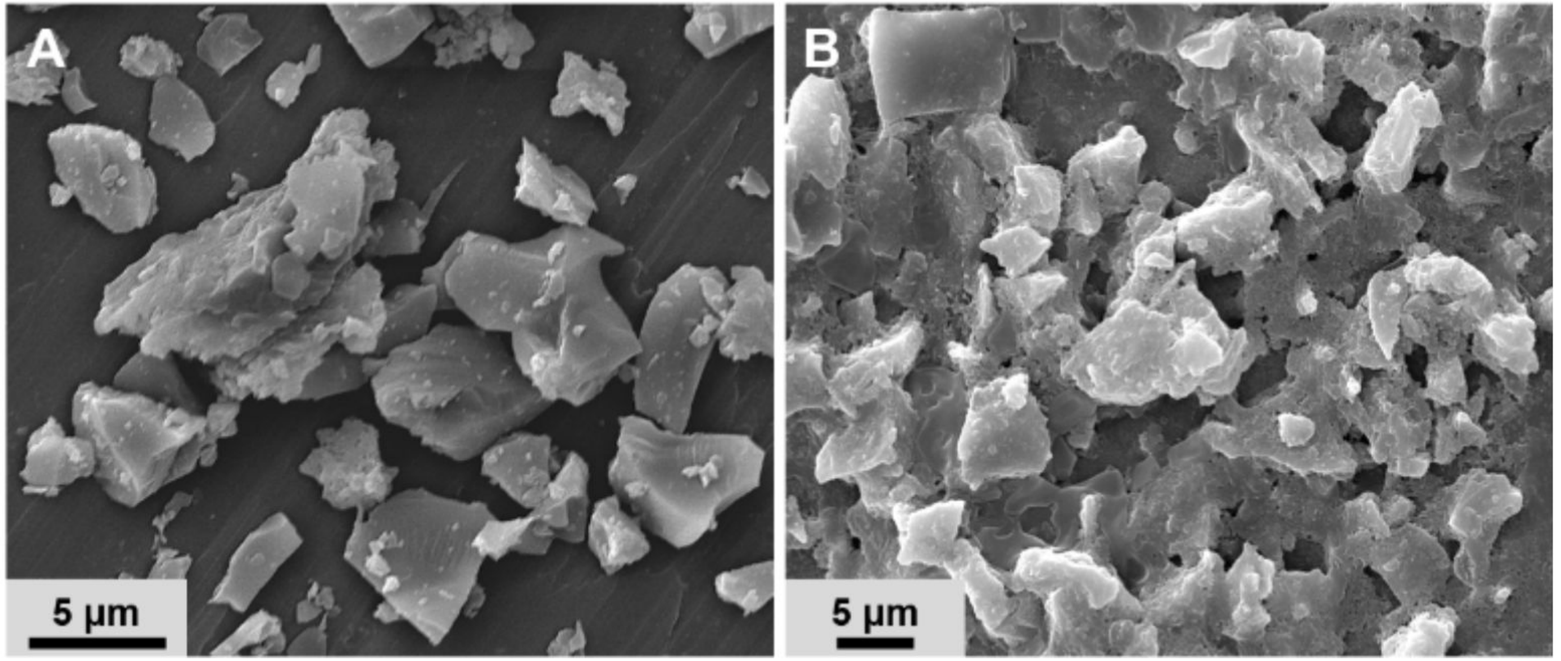
$\vec{b} \rightarrow \overrightarrow{b_0} + (x, 0, z)$;

(��, ⬚ ∈ [0,1]) - fractional coordinates

SFEs of (010) direction with (0, 0), (0, 0.5), (0.5, 0) and (0.5, 0.5) slip configurations on the (110) plane of SiO2

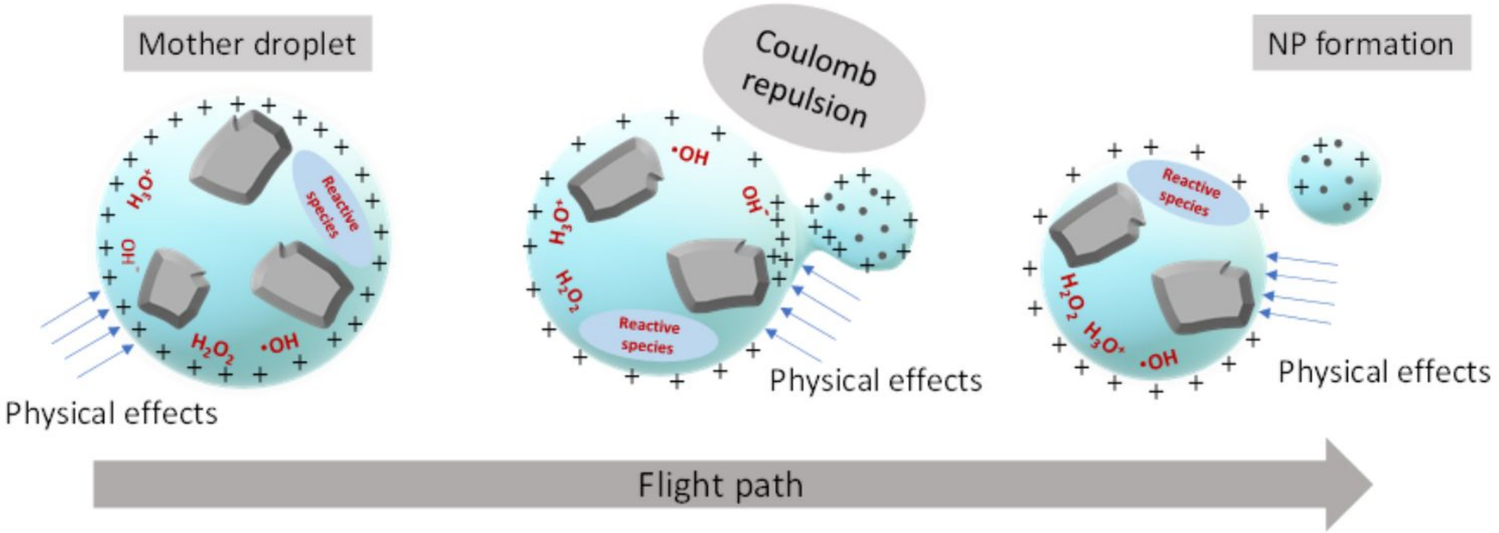
Mass Spectrometry of the Fragments

Effect of charged microdroplets on quartz



Increased surface roughness after the spray

Mechanism of nanoparticle formation



Rayleigh, On the equilibriu m of liquid conducting mas ses charged with electricity , Philosophical Magazine, 1 882

$Q = 8\pi\ (\epsilon 0\ \gamma R3)1/2$

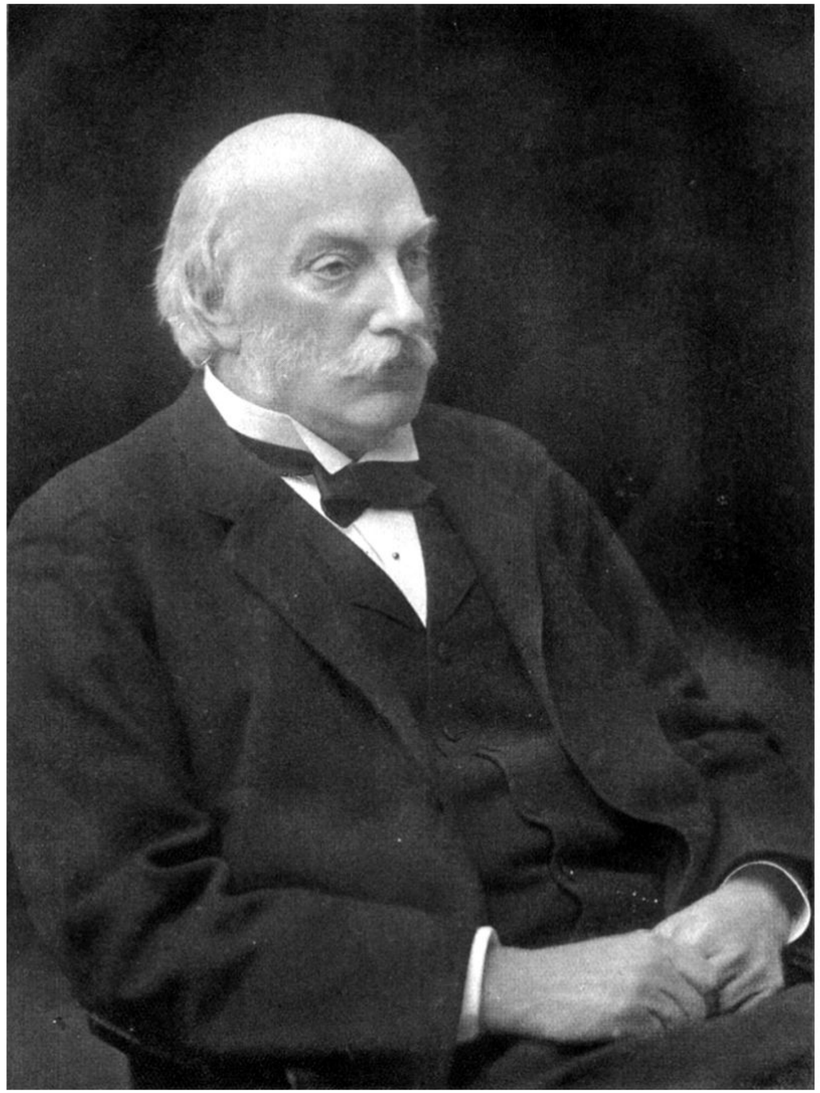
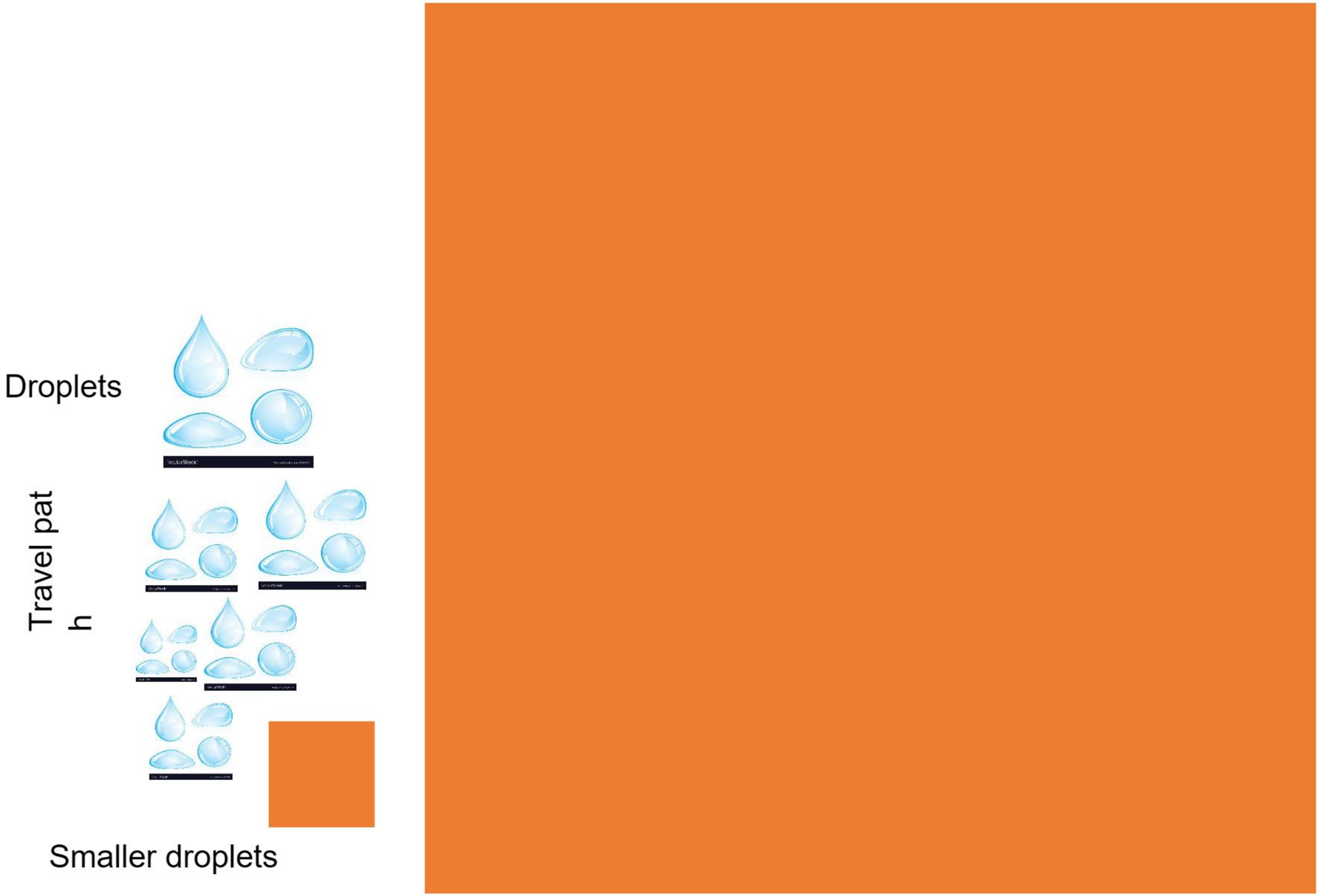


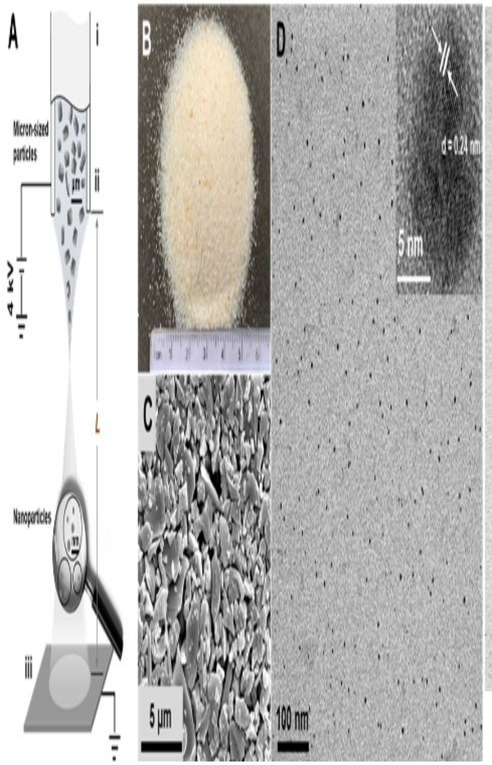
Image from Wikipe dia

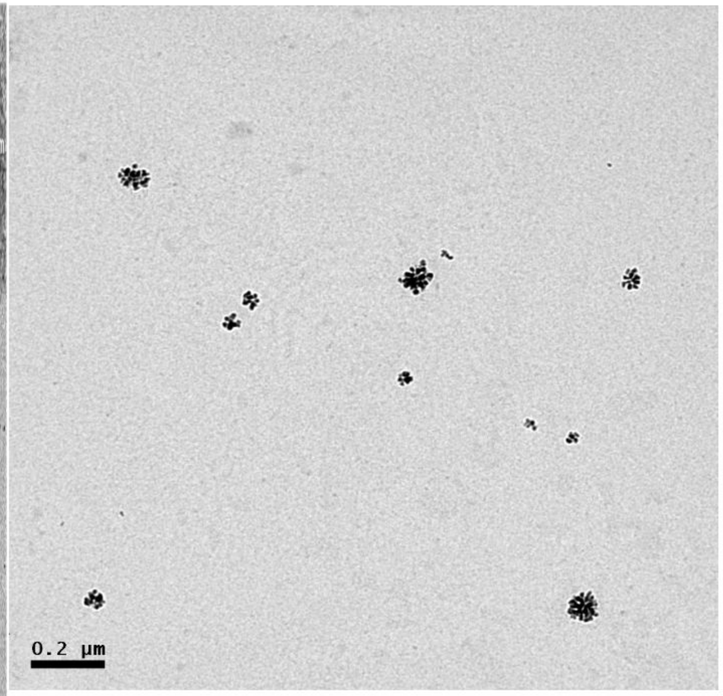
Understanding Microdroplets

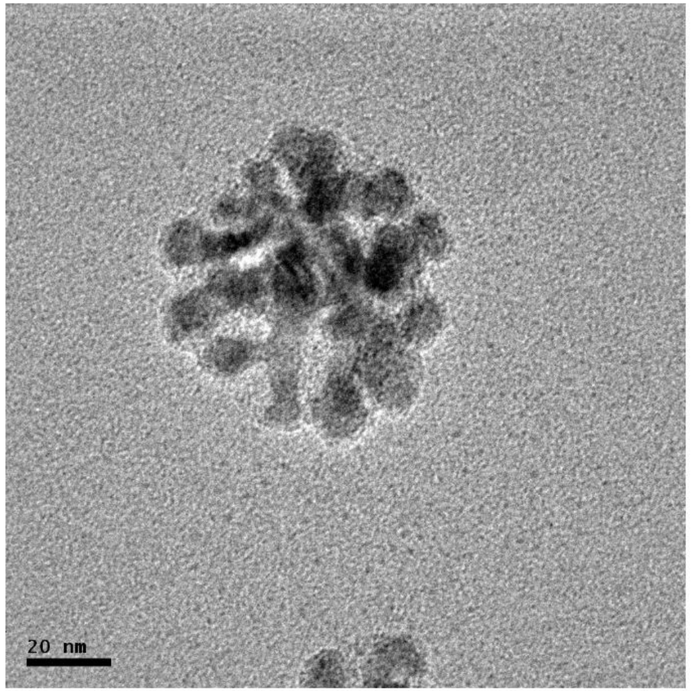


Grazia Rovelli, et. al. *Chem. Sci.*, 2020, 11, 13026–13043.

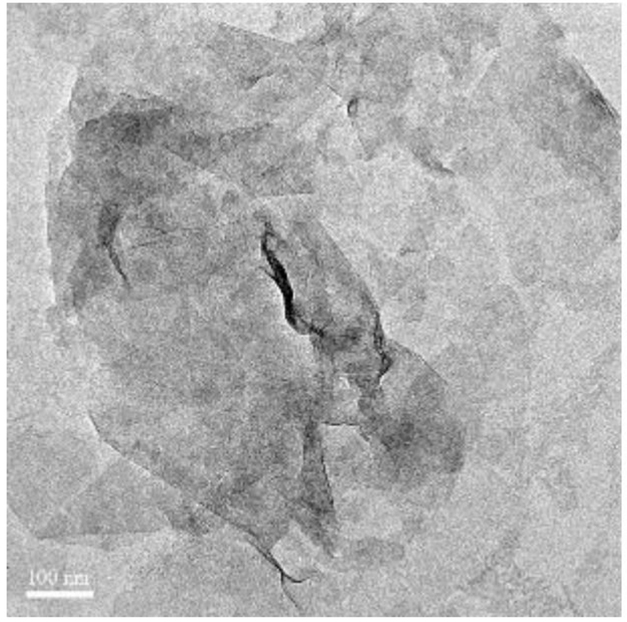
How do they for m?

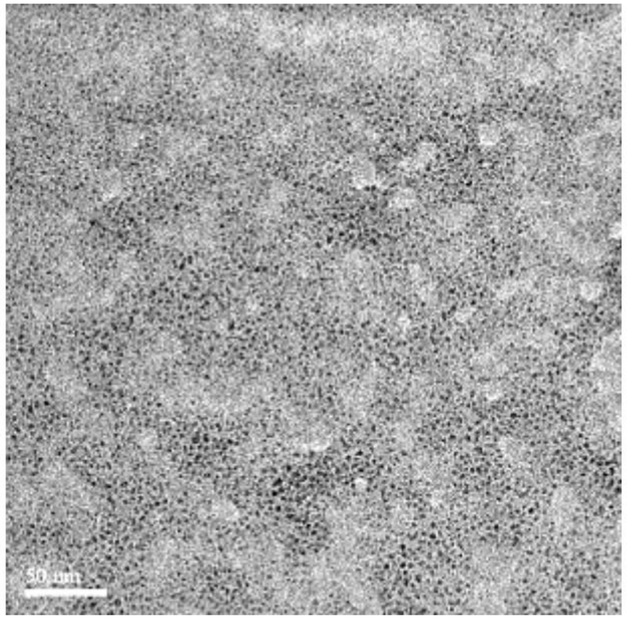


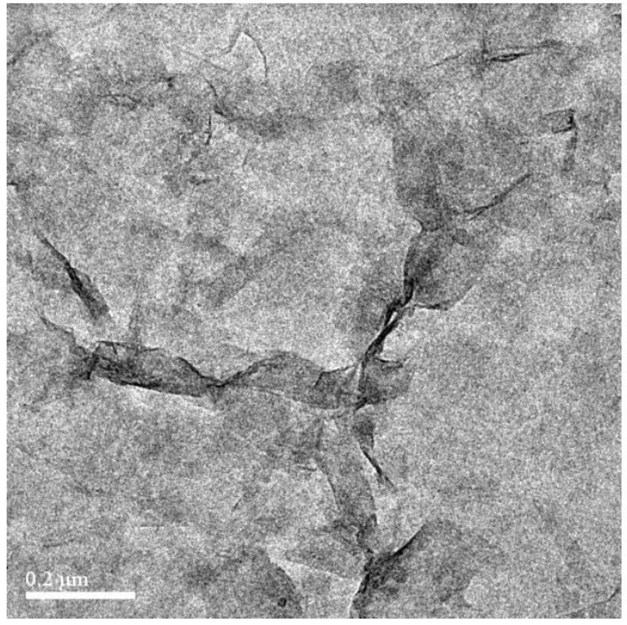


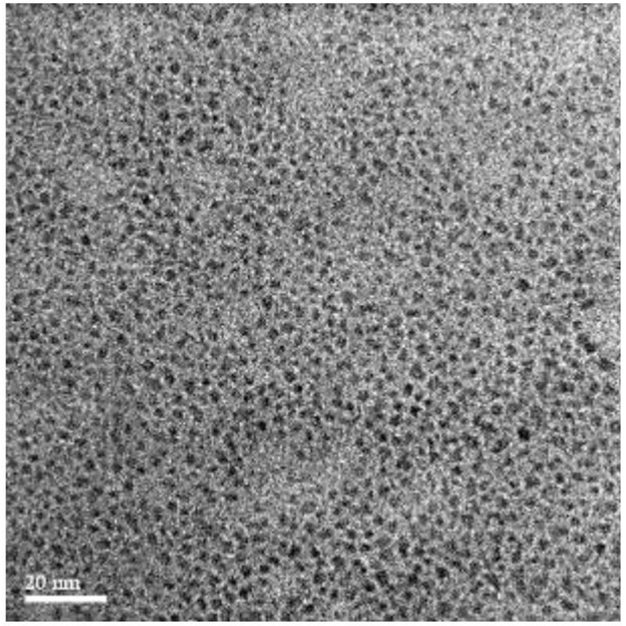


MoS2 Nanosheets









MoS2 Nanosheet

MoS2 Nanoparticles

Unveiling steps in the weathering of miner als

Anubhav Mahapatra et al, Chem. Comm. 2
025

Disintegration of quar
tz

Vision

Make soil using proce
ssed wastewater and
make deserts bloom.

Conclusions

Natural minerals break spontaneously in charged water microdroplets

It occurs only in water… so far

Studies on a variety of materials

Facile due to proton-induced slip

Detailed investigations are essential to know more

Implications to the production of specific nanomaterials and soil in genera
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Clean water for all

https://www.peopleswaterdata.org

Department of Science and Technology

Institute of Eminenc
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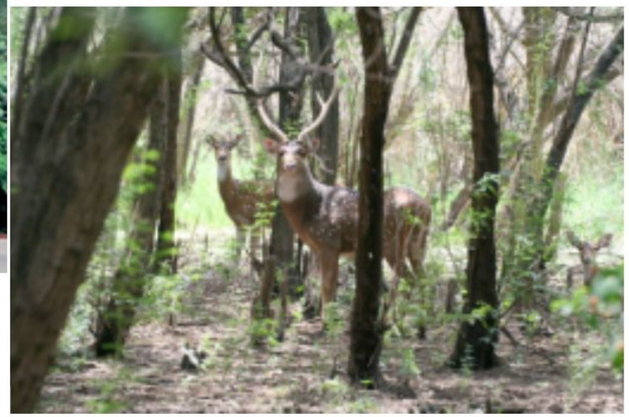
Indian Institute of Technology Madras



Bhaskar Ramamurthi/V. Kamakot

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Thank you all