Charging behavior of the calcite (100) surface investigated by KPFM

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Motivation

Detailed knowledge about the **contact charging** of **dielectric materials** is of great interest for technological applications like **tribocharging separation**[1,2] of mineral particles. The underlying **mechanisms** are still **not** well **understood**[3]. So far, AFM based charging investigations were just performed on dielectric thin layers.[4-6]

Here, an attempt is made to study the electric charging of well-defined surfaces (calcite monocrystals) upon contact with a conductive AFM tip.

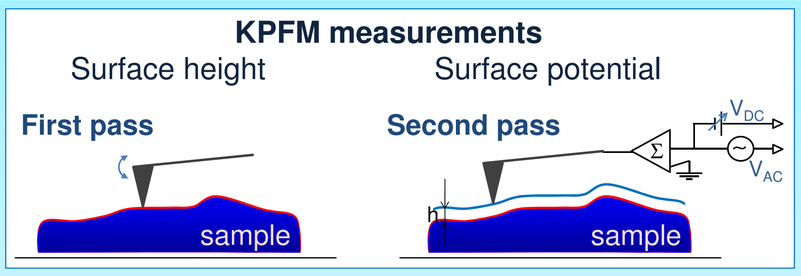
Kelvin probe force microscopy (KPFM)[7] was applied to verify the electrostatic characteristic of the surfaces before and after contact charging. Both, tribocharging due to **rubbing** and **static contact** charging with applied tip **bias** have been investigated.

A prototype of the coaxial triboelectrostatic separator[8]

Experimental

Equipment:
Asylum Research MFP-3D AFM

Probes:
TiN coated tips for noncontact AFM,
spring constant ~70 N/m,
tip curvature radius ~35 nm

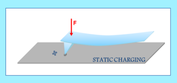


Samples:
monocrystalline **calcite**, $CaCO_3$ (100), MTI Corporation, USA

Conditions:
air, room temperature, 50 % r.H., applied forces: 2-3 µF, applied voltage: ±10 V

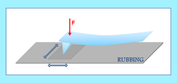
Measurement procedure:
KPFM measurements → charging (rubbing or static contact) → KPFM measurements
repeating

Results



Static charging

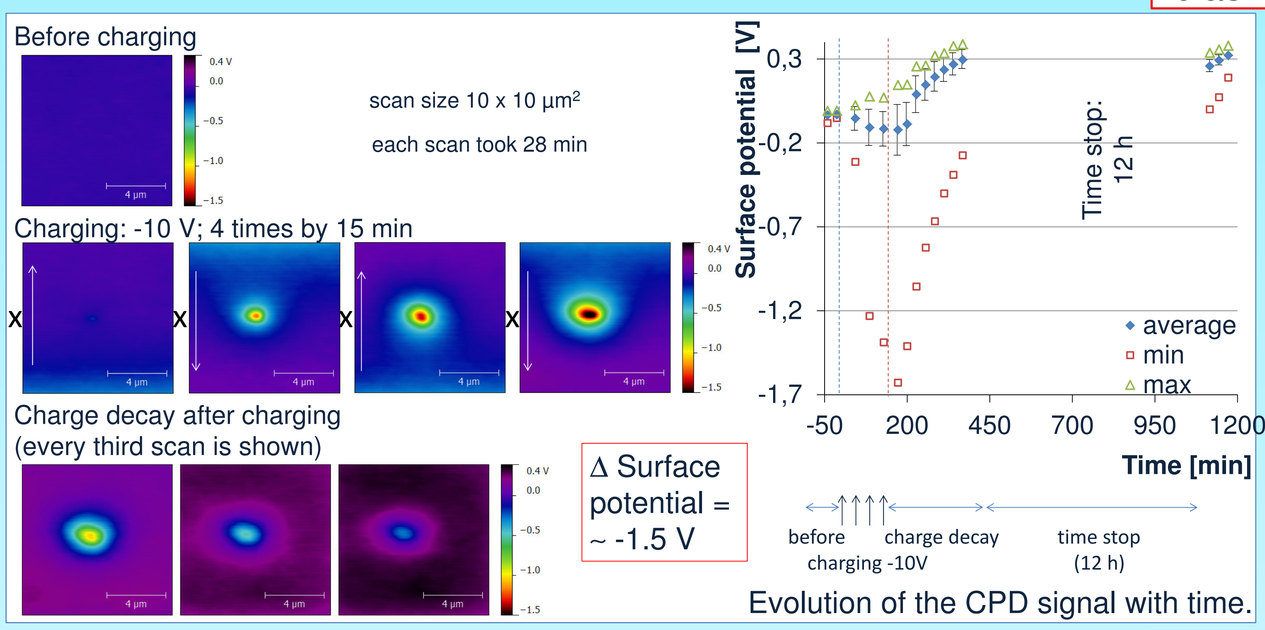
The AFM tip with applied bias (±10 V) Is brought into contact with a defined force (~2 µN) and for defined time (15 min).



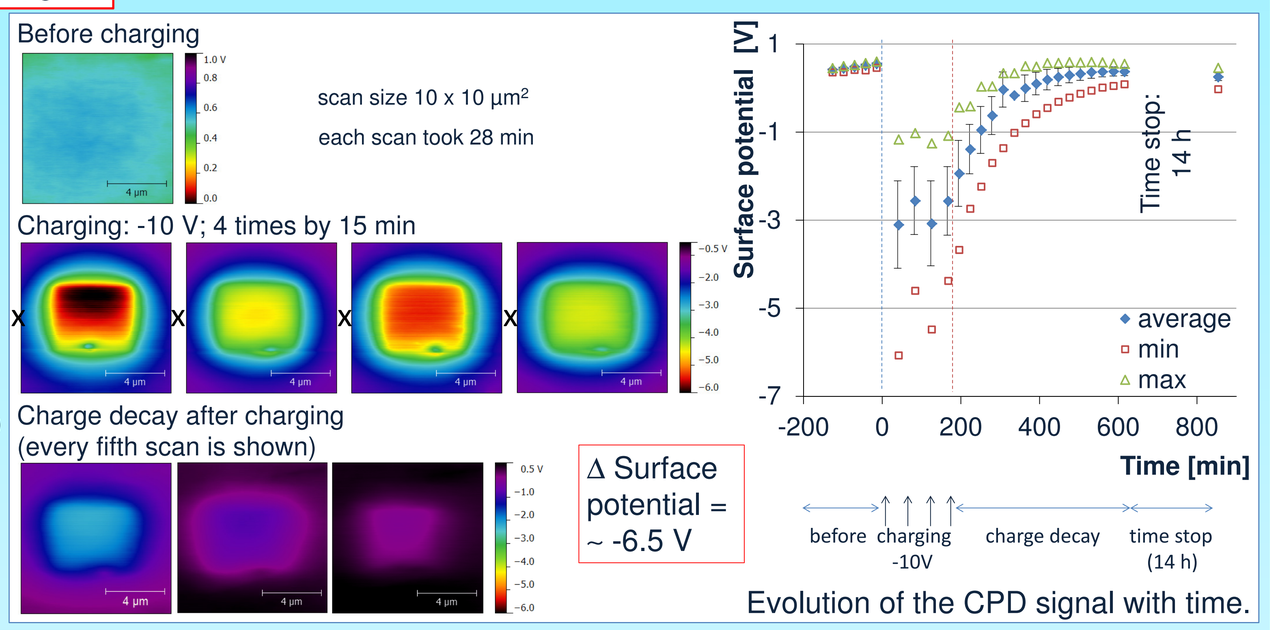
Rubbing

The AFM tip with or without applied bias (0 V or ±10 V) is dragged on a chosen surface area (4 x 4 µm²) with defined force (~3 µN) and speed (0.30 Hz).

bias -10 V

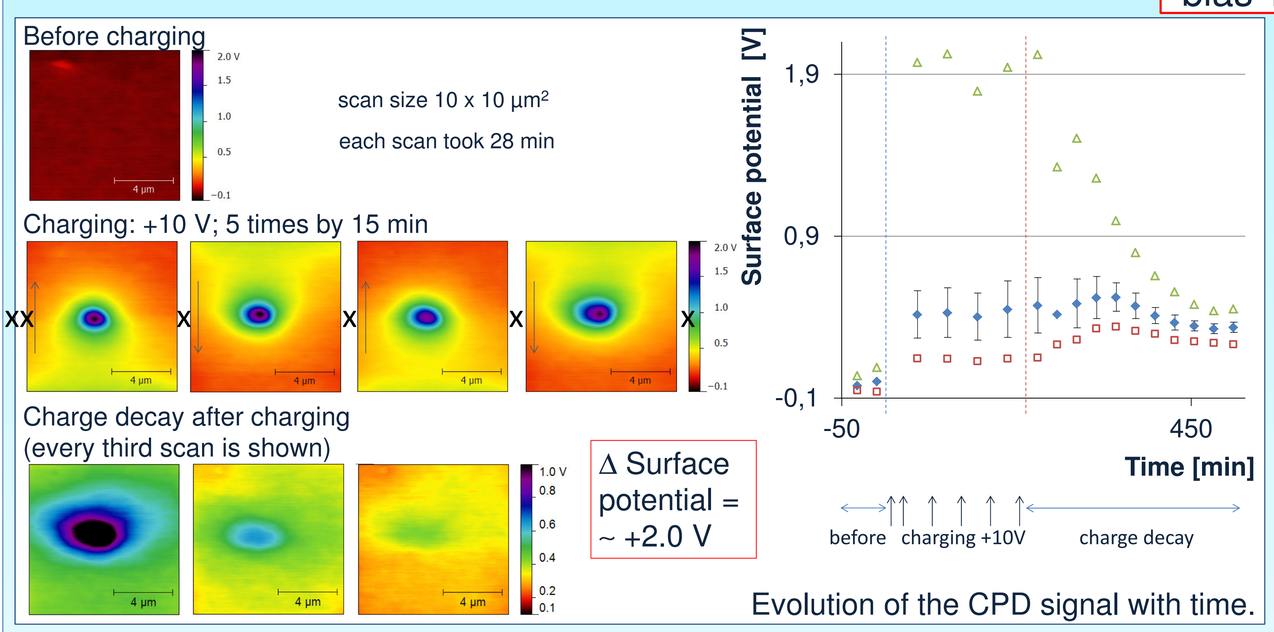


Evolution of the CPD signal with time.

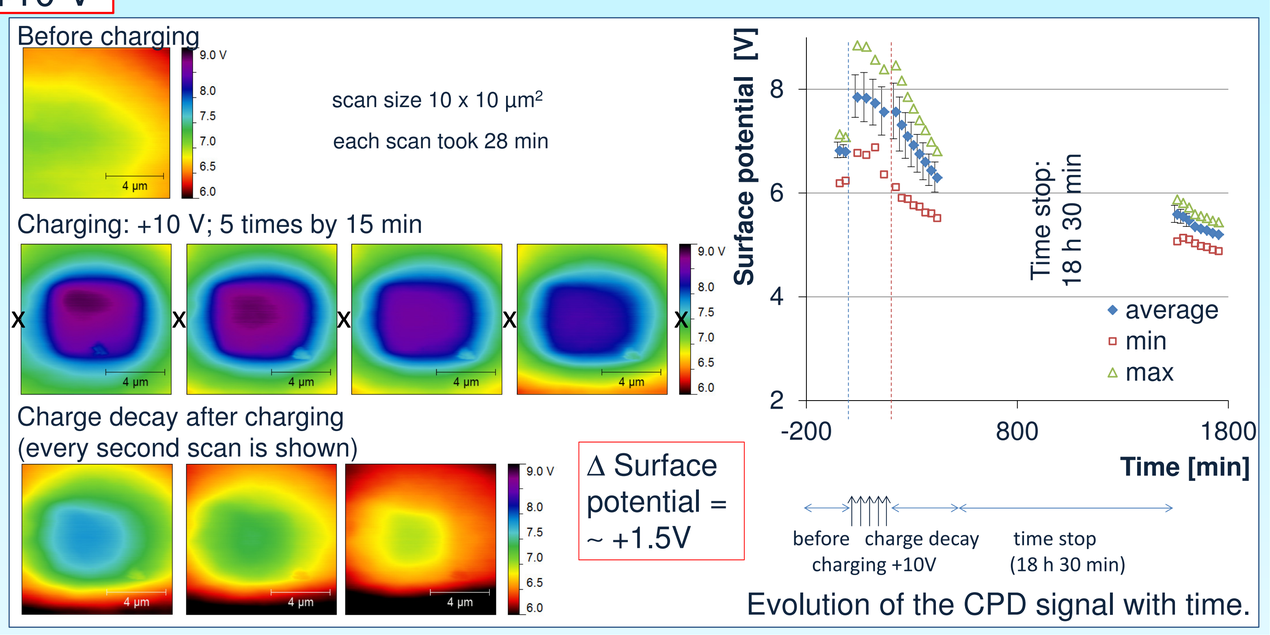


Evolution of the CPD signal with time.

bias +10 V



Evolution of the CPD signal with time.



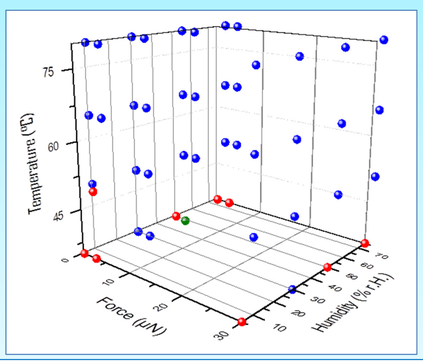
Evolution of the CPD signal with time.

Conclusion

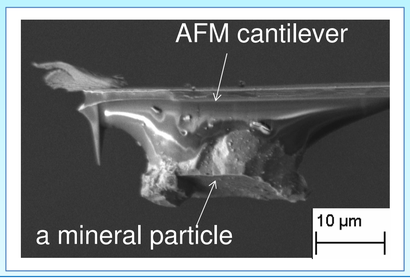
- Successful charging by static contact as well as by rubbing is confirmed by CPD change.
- The resulting surface charge depends on:
  - the type of charging (static charging, rubbing),
  - the value of the initial surface potential.
- Charging can be reversed by application of opposite tip bias.
- Charge decays roughly exponentially with time.

Outlook

Investigation of the influence of parameters like:
- contact force,
- humidity,
- rubbing speed,
- temperature.



Performing contact charging with crystal particle attached to the AFM cantilever.



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