

Rochelle Salt Experimental Applications Proposal

NanoArc relevance first; future ACE-driven materials and process applications second

Project: NanoArc / ACE materials experimentation

Status: Draft proposal - not approved, frozen, or implemented

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Authority: Tristan remains the design, safety, freeze-break, and interface-approval authority

Related architecture: ACE RevB/RevC Modular Applications Architecture Proposal

Executive summary

Rochelle salt should be treated as a cheap experimental material rather than a component awaiting an assigned job. The immediate objective is to determine whether its piezoelectric, dielectric, environmental, and tartrate-chemistry behavior yields anything useful to NanoArc. If not, the same experiment framework can still become a reusable ACE-driven materials-characterization capability.

Recommended order: piezo/contact sensing -> electrical and resonance characterization -> environmental and batch repeatability -> NanoArc suitability decision -> tartrate electrochemistry screening -> future ACE automation.

Working assumption supplied by the project owner: Rochelle salt can be produced cheaply enough that destructive, comparative, and batch experiments are economically acceptable.

1. Purpose and decision question

This proposal organizes candidate uses for Rochelle salt by project value. It deliberately prioritizes experiments that can answer a NanoArc design question before experiments that are merely interesting. It then identifies which successful test methods could become future ACE-controlled applications.

Primary decision question: Does Rochelle salt provide a repeatable property that is useful enough to NanoArc to justify further engineering work?

Secondary decision question: Can the test infrastructure itself become a useful ACE application even if Rochelle salt is ultimately rejected as a NanoArc material?

2. Relationship to the ACE modular architecture

The existing ACE RevB/RevC architecture proposal assigns ACE high-level sequencing, profiles, logging, limits, fault handling, module identity, and permission while leaving process-specific sensing and actuation inside application modules. A materials-characterization fixture fits that boundary cleanly: ACE can supervise a test sequence without requiring the controller core to know the electrical details of Rochelle salt or any future specimen.

ACE core	Profiles, sequencing, logging, operator workflow, validity checks, timeouts, result records
Materials module	Excitation, signal conditioning, measurement ranges, test-fixture I/O, local protection
Specimen fixture	Rochelle salt crystal or later material under test; replaceable and identifiable
Future expansion	Same module/API can accept piezoceramics, thermistors, salvaged sensors, dielectric materials, or electrochemical cells

3. Candidate applications, sorted by project value

Priority	Candidate use	NanoArc value	Future ACE value	Disposition
1	Piezo force/contact sensing	High	High	Test first
2	Electrical / LCR / resonance characterization	Medium-High	Very high	Test first

Priority	Candidate use	NanoArc value	Future ACE value	Disposition
3	Temperature, humidity, and aging behavior	Medium	High	Required qualification data
4	Batch-to-batch repeatability of homemade crystals	Medium	Very high	Required before integration
5	Vibration / impact sensing	Medium	High	Follow-on if piezo response is useful
6	Copper/tartrate electrochemistry screening	Potentially high	High	Separate exploratory branch
7	Crystal orientation and geometry study	Low-Medium	Medium	Only after useful signal found
8	Electrode/contact method study	Low-Medium	Medium	Only after useful signal found
9	Pressure-pad or multi-element array	Low for Rev A	High	Future concept
10	Acoustic/contact microphone	Low	Medium	Curiosity / secondary
11	Piezo actuator / acoustic transmitter	Very low	Medium	Curiosity / secondary
12	Crystal-growth automation	None direct	High	Future ACE application
13	Ferroelectric / dielectric research	Very low	Medium-High	Future materials work

4. NanoArc-first research branches

4.1 Force and contact sensing

Determine whether a Rochelle-salt element can produce a repeatable electrical response to contact force, taps, vibration, or other mechanical events relevant to a handpiece or fixture. The objective is not to adopt Rochelle salt immediately; it is to determine whether the available signal is useful enough to justify comparison against more rugged piezoelectric materials.

4.2 Electrical and resonance characterization

Measure capacitance, impedance behavior, loss, and any mechanically induced response across a controlled set of samples. This establishes whether the material behaves consistently enough to instrument and whether geometry or orientation materially changes the useful signal.

4.3 Environmental and aging characterization

Measure how the useful electrical response changes after controlled exposure to ordinary changes in temperature and humidity and after storage. This is a go/no-go test for any real NanoArc integration, because a sensor whose calibration drifts unpredictably is more useful as a specimen than as a component.

4.4 Batch repeatability

Compare multiple independently produced crystals using the same test fixture. A cheap material is only engineering-useful if the property of interest is predictable or calibratable across batches.

4.5 Tartrate electrochemistry screening

Treat the tartrate chemistry as a separate exploratory branch adjacent to the proposed electroplating application. The first question is only whether adding or varying tartrate materially changes controlled copper-system behavior under bench conditions. This proposal does not assume that Rochelle salt belongs in a plating bath and does not define a plating recipe.

5. Proposed experimental program

Phase 0 - Sample registry and baseline

Assign each specimen an ID and record growth batch, dimensions, orientation if known, electrode/contact method, storage condition, and date. Photograph or sketch mounting geometry. The point is traceability, not perfection.

Phase 1 - Passive electrical characterization

Record capacitance/impedance-related measurements using available bench instruments at repeatable conditions. Repeat measurements to estimate short-term stability before introducing mechanical variables.

Phase 2 - Mechanical response screening

Use a simple repeatable fixture to apply comparable contact, tapping, bending, or vibration events. Capture peak response, waveform shape when possible, noise floor, polarity/orientation effects, and recovery between events.

Phase 3 - Environmental and aging tests

Repeat the same electrical and mechanical tests after controlled storage or environmental changes. Reject any candidate use that depends on a property that drifts too far to calibrate or reproduce.

Phase 4 - NanoArc suitability decision

For any promising response, compare the benefit against simpler commercial sensor types. Decide whether Rochelle salt is a practical component, a useful low-cost test surrogate, or merely a teaching/characterization specimen.

Phase 5 - Tartrate electrochemistry screening

Run a separate, labelled electrochemistry study using simple bench cells before considering any plating-pen geometry. Compare controlled systems with and without tartrate-related chemistry. Record observations and electrical behavior; do not infer pen suitability from tank behavior alone.

Phase 6 - ACE automation

If the test workflow proves repetitive enough to justify automation, define a materials-test application module. ACE would select profiles, identify the fixture, sequence tests, verify data freshness, log results, and reject incompatible specimens or modules without absorbing process-specific analog circuitry into the core.

6. Minimum experiment record

Every useful result should be reproducible from the record. A lightweight worksheet is sufficient at first; automation can come later.

- Specimen ID and growth batch
- Geometry, approximate dimensions, and mounting/orientation
- Electrode/contact method
- Instrument and measurement mode
- Ambient or controlled test condition
- Mechanical stimulus or test-fixture state
- Measured value, waveform summary, or observed response
- Repeat count and spread between repeats
- Visible damage, degradation, or drift
- Decision: repeat, modify fixture, compare another material, or stop

7. Instrumentation path

The program can start manually and become more instrumented as required. No custom PCB is justified until the first-pass measurements show that a property is worth automating.

Stage	Typical instrumentation	Purpose
Manual screening	DMM, simple mechanical fixture, notebook	Reject obviously useless samples quickly
Electrical characterization	LCR/impedance-capable meter	Compare capacitance, losses, frequency behavior, and sample repeatability

Dynamic characterization	Oscilloscope or suitable acquisition front end	Capture transients, noise, resonance, polarity, and waveform shape
Automated characterization	ACE + application module + fixture	Run repeatable profiles and accumulate comparable datasets

8. Decision gates

Gate A - Detectable: Does the specimen produce a signal or electrical behavior clearly distinguishable from fixture noise and contact artifacts?

Gate B - Repeatable: Does the response repeat closely enough on the same specimen to be useful?

Gate C - Reproducible: Do multiple homemade specimens show comparable behavior, or can each be calibrated practically?

Gate D - Environmentally tolerable: Does normal environmental variation leave enough stability for the proposed role?

Gate E - Better than the alternative: Is there a real advantage over a cheap commercial sensor or material?

Gate F - Worth automating: Would ACE supervision materially improve the experiment through repeatability, logging, sequencing, or comparison across specimens?

9. Non-goals and boundaries

- Do not redesign frozen RevA around Rochelle salt.
- Do not assign Rochelle salt a safety-critical interlock or protection role before extensive characterization.
- Do not assume a successful piezo demonstration implies suitability for a permanent NanoArc sensor.
- Do not assume tartrate chemistry is useful to the electroplating module without controlled comparative data.
- Do not build a dedicated ACE PCB merely to automate an experiment that has not yet produced useful manual data.
- Do not let a Rochelle-salt-specific experiment contaminate the revision-neutral ACE core; specimen-specific behavior belongs in the application module or test profile.

10. Proposed deliverables

- Rochelle salt specimen registry and naming convention.
- Simple repeatable mechanical test fixture.
- Baseline electrical-characterization worksheet.
- Environmental/aging comparison worksheet.
- Batch-repeatability summary.

- NanoArc suitability decision for force/contact, vibration, and other discovered behaviors.
- Separate tartrate electrochemistry screening note if that branch proceeds.
- Draft capability definition for an ACE materials-characterization module if automation becomes justified.
- Final disposition: NanoArc component, test surrogate, future ACE specimen, electrochemistry reagent, or no further work.

11. Current recommendation

Treat Rochelle salt as specimen #1 for a NanoArc-first materials test program, not as a committed component.

Start with piezo/contact response, electrical characterization, environmental behavior, and batch repeatability. Pursue tartrate electrochemistry separately. Only after a manual experiment produces repeatable, decision-relevant data should an ACE application module be designed to automate it.

Why this is useful even if Rochelle salt fails: the test method, specimen registry, fixture concepts, and ACE capability boundary remain reusable for later materials and sensors.

Appendix A - Source and architecture notes

This proposal was compiled from the project discussion on 2026-08-11 and the existing "ACE RevB/RevC Modular Applications Architecture Proposal" dated 2026-08-11. The latter defines the key architectural principle used here: ACE remains the supervisory core while application modules own process-specific sensing, actuation, protection, and interfaces. No connector pinout, electrical interface, or RevA modification is authorized by this document.