Plan 3 – Full Technical Rationale + Formula-Supported Explanation

This PDF preserves formulas without Markdown rendering issues.—

3.1 Mean Free Path λ

$\lambda = k_B * T / (\sqrt{2} * \pi * d^2 * P)$

Condition:

$\lambda \gg L_{channel}$ → ballistic transport.

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3.2 Fowler–Nordheim Injection

$J = A * (E^2 / \phi) * \exp(-B * \phi^{3/2} / E)$

Purpose: control electron injection energy.

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3.3 Ramsauer–Townsend Scattering Minimum

$\sigma(E)$ → minimum at specific electron energies.

Meaning: inert gas becomes nearly transparent.

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3.4 Disjoining Pressure (Liquid Confinement in 1.0)

$\Pi(h) = \Pi * \exp(-h / \lambda_D)$

Used to justify stable nanoscale gas layer.

3.5 Electrowetting (Instability of Liquid-Based 1.0)

$\cos\theta(V) = \cos\theta + (\varepsilon * \varepsilon_r * V^2) / (2 * \gamma * t)$

Explains why liquid moves under electric fields.—

3.6 Pinning Force (Solid SAM Layer in 2.0)

$F_{pin} = \Delta\gamma * L$

Solid interface → no creep, stable confinement.

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3.7 Marangoni Number (Interface Oscillation Check)

$Ma = |d\gamma/dT| * L * \Delta T / (\mu * \alpha)$

At nanoscale: $Ma << 1$ → interface stable.

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3.8 Transit Time vs Scattering Time

$\tau_{scattering} >> \tau_{transit}$

Electron transit across 100 nm: ~1e-13 s.

Disturbances occur slower → electron unaffected.

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3.9 Joule Heating Reduction

$P = I^2 * R$

If R is extremely small → negligible heating.

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3.10 Physical Closure Summary

• Gas confinement stable (1.0 & 2.0)

• Scattering suppressed (RT + λ/L)

• Electron energy controllable (F-N)

• Solid interface stable (SAM pinning)

• Transit outruns disturbances (τ)

• Joule heating minimized

• No superconductivity mechanism involved