

Adaptive Neuro-Shield™ (ANS) — PPA-1, the Base Invention

Defense materials that evolve with the field.

A thermal self-healing, frequency-adaptive EM-shield composite — one cured laminate that absorbs and scatters incident energy, electrically re-tunes to the threat band, and self-repairs (>90% conductivity in ~5 min at a low ~80 °C trigger).

The self-healing, frequency-adaptive electromagnetic-shielding composite at the foundation of the ANS portfolio — **one smart material that blocks, re-tunes, and repairs itself.**

NO NDA REQUIRED TO READ THIS PAGE · ENABLING MATERIAL ARCHITECTURE & PROCESS DETAIL AVAILABLE UNDER MUTUAL NDA

Filed IP fact — as disclosed in the filed provisional

Engineered design target — projected from published, lab-validated building blocks (constituents at TRL 4–6); integrated-system test is the next step

① CAPABILITY — ADAPTIVE ATTENUATION, 0.1 HZ–100 GHZ

- ▶ **Self-tuned EM shielding across 30 MHz–100 GHz** (EMI / EMP / directed-energy) — **~52–80 dB** shielding effectiveness in the X-band at 0.1 mm.
Absorbs and scatters incident EM/EMP/directed-energy across 30 MHz–100 GHz — broadband shield, single laminate.
- ▶ **Bio-frequency damping 0.1–40 Hz** (neural-field stabilization), plus epsilon-near-zero (ENZ) auto-matching at **240–380 MHz**.
Auto-tunes peak absorption to the incoming band — ENZ resonance steered to the live threat frequency.

② SELF-HEALING & FREQUENCY-ADAPTIVE

- ▶ **Self-healing: >90%** conductivity recovery in **~5 min** at a **~80 °C** trigger — inside normal platform thermal cycling.
Self-repairs conductive damage in-field — >90% recovery in ~5 min at a low +80 °C thermal trigger.
- ▶ **Frequency-adaptive: ferroelectric P(VDF-TrFE)** phase lets the composite electrically re-tune which band it blocks hardest.
Electrically re-tunes its strongest absorption band — ferroelectric phase shifts the shield to match the attack.

③ ARCHITECTURE — ONE SELF-HEALING MATRIX

- ▶ **A single self-healing matrix** combining: **MXene + graphene** (conductive); a **ferroelectric** phase (tunable); a **soft-magnetic** phase (low-frequency); and a **dynamic-covalent polymer** (self-heal). Built by **dispersion → deposition → cure**, with **sensorized feedback**.
Multi-phase self-healing laminate — conductive, frequency-tunable, and thermally self-repairing in one cured material.

④ STATUS & IP

- ▶ **IP — U.S. provisional FILED:** Application #64/020,126, filed **28 Mar 2026**, titled "Adaptive Neuro-Shield — Self-Healing, Frequency-Adaptive Electromagnetic Shielding Composite."
Base provisional on file — priority date locked at the parent of the ANS portfolio.
- ▶ **Maturity (honest):** constituent materials at **TRL 4–6**; integrated validation is the next step.
Constituent phases at TRL 4–6 — integrated-laminate validation is the remaining step.
- ▶ **Sovereign IP:** wholly inventor-owned — no university or government-funding encumbrance.
Wholly inventor-owned — unencumbered, free and clear to license.

WHAT PPA-1 IS — The parent invention of the ANS portfolio: a single load-bearing composite skin that shields across a broad electromagnetic band, re-tunes which band it blocks hardest, and heals its own damage in minutes — all in one material rather than a stack of bolt-on parts. PPA-2 (filed) hardens it; PPA-3 / HETD (filed) adds the structural frame; PPA-4 / ARI (filed) prints it into parts. **All four applications of the ANS portfolio are now on file at USPTO.**

Enabling material architecture & process detail available under mutual NDA. This page states *what* the material is engineered to do, with numbers. It deliberately does *not* disclose the formulations, layer-stack recipes, mixing ratios, or process parameters — the proprietary *how*.

Non-proprietary technical overview — no NDA required to read this page. Material scoped as a passive / responsive defensive protective skin (no offensive EM function). Figures labeled as targets are engineered design targets projected from published, lab-validated constituent materials (TRL 4–6); integrated-system performance is not yet bench-tested.