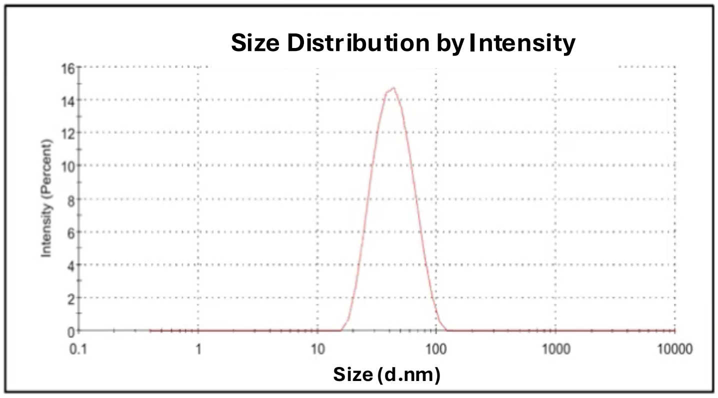
Paretor
155 Arlington St
Watertown, MA 02478

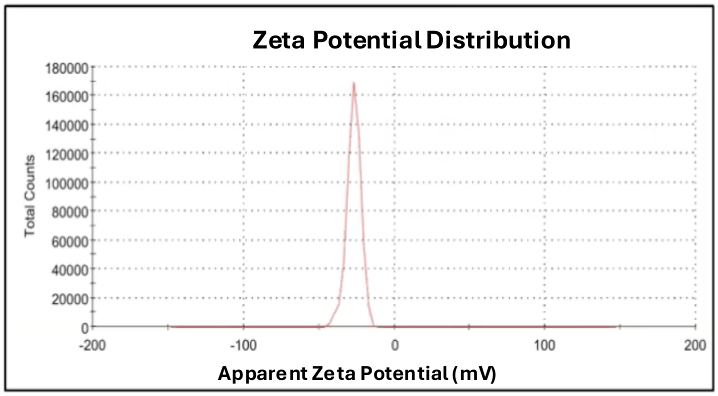
Paretor – Predictable Delivery Protocols & Formulations

Mineral Nanoparticle Colloid | Cell transfection | Cargo Carrier

Dynamic light scattering experiments show a single peak with normal distribution*



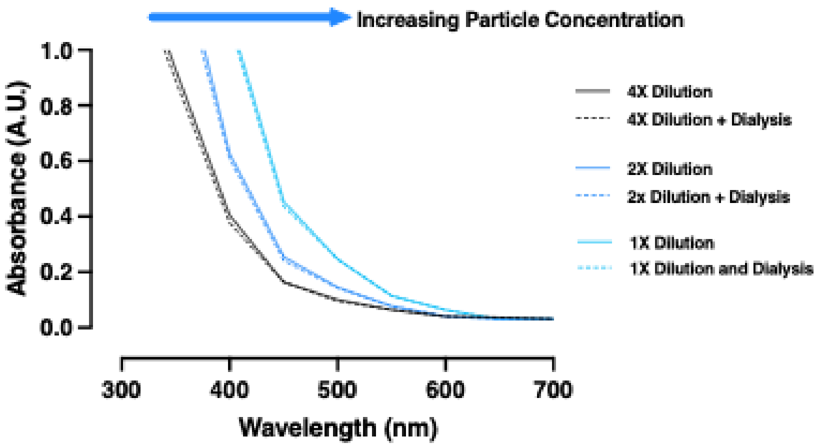
This is a single, uniform population with a negative charge of less than -30mV*



*Crude particles taken directly from the reactor

- Particles are colloidal, uniform in size and charge
- Particles are not magnetic
- Straightforward to modify post-synthesis

Preservation of Paretor MNC Optical Profile with Dialysis



Interpretation: Paretor mineral nanoparticle colloids remain structurally intact and do not release diffusible iron under buffer exchange conditions.

Dialysis against PBS does not alter the absorbance profile, indicating the signal is dominated by particle-associated iron and diffusible iron species are minimal under these conditions. Data suggest MNCs remains structurally intact and does not release diffusible iron under buffer exchange conditions. Data also suggest there are minimal free iron residuals present post synthesis. Absorbance scales with particle concentration.

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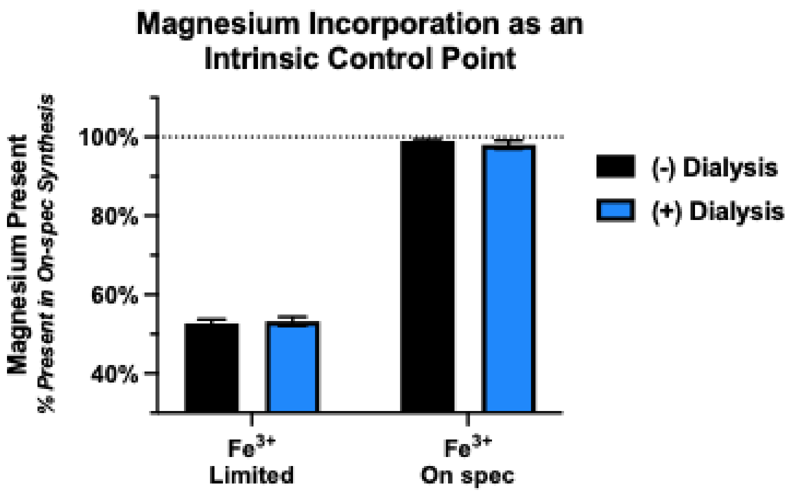
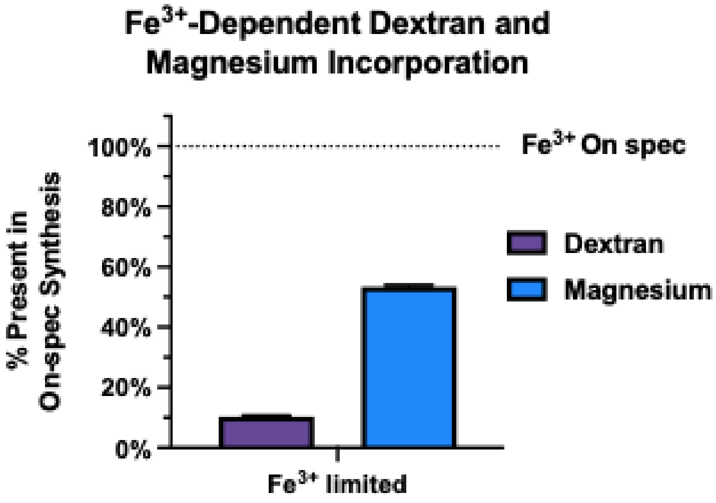

Magnesium Incorporation as an Intrinsic Control Point

Quantitative magnesium incorporation across two representative ETAERION batches formulated under Fe^{3+}-limited versus Fe^{3+}-on-spec conditions. Magnesium incorporation enforces a deliberately non-crystalline, defective Fe(III):Mg coordination architecture and provides a direct, intrinsic read-out of ferric iron availability during synthesis. As illustrated, Mg^{2+} content was quantified before and after dialysis using a calmagite-based colorimetric assay calibrated against a 5× standard curve (baseline-subtracted A_{700} measurements; linear regression $R^2 \geq 0.99$). The results demonstrate that the ETAERION process self-reports its own convergence via coordinated Fe^{3+}/Mg^{2+} incorporation, enabling predictable stabilization of amorphous structure without crystalline nucleation.

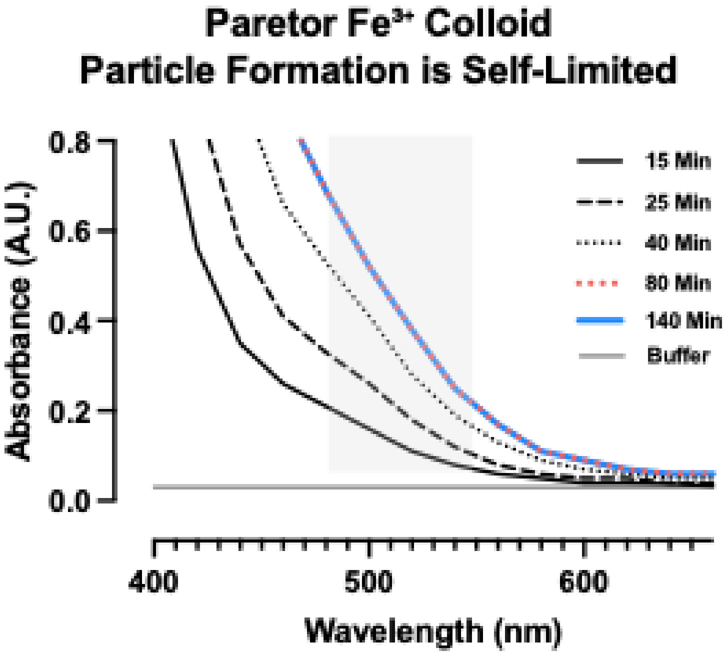

Fe^{3+}-Dependent Dextran and Magnesium Incorporation

This figure further illustrates the dependence of both magnesium incorporation and dextran association on ferric iron levels during synthesis. Under conditions in which Fe^{3+} availability deviates from the defined process window, magnesium incorporation and polysaccharide association both fail, yielding no stable nanoparticle product. This controlled failure mode highlights the process-encoded nature of the amorphous Fe^{3+} scaffold, distinguishing it from legacy iron-oxide nanoparticles defined solely by composition (e.g., magnetite or maghemite). The data support the conclusion that the amorphous iron-oxide nanoparticles constitute a distinct pre-crystalline class, whose structure is defined not by crystalline identity but by the coordinated synthesis parameters that establish accessible Fe(III) sites required for universal phosphonate-based post-synthetic functionalization

Interpretation:

- Lower presence of magnesium when conversion of Fe^{2+} (which does not bind Mg) to Fe^{3+} (which does bind Mg), also suggests direct incorporation
- The proportional decreases in dextran levels indicated dextran is **not coating the particle, but integrated**
- When conversion of Fe^{2+} (which does not bind Mg and dextran) to Fe^{3+} (which does bind Mg and dextran) is limited, **both** dextran and Mg are diminished

Optical Evidence of Colloidal Locking During Fe^{3+} Iron Oxide Synthesis



Time-resolved UV–Vis absorbance spectra collected over a 140-minute aqueous synthesis show smooth, monotonic spectral decay without discrete optical features. The shaded region (≈480–550 nm) indicates the wavelength range typically associated with crystalline spinel ferrite signatures, which are not observed at any time point.

- In-process samples' time-resolved UV–Vis absorbance patterns are consistent with a lack of crystal formation
- Particle synthesis appears complete (particles "lock") at 80 minutes without the addition of additional components to limit particle size (red and blue lines overlap for 80 and 140 minutes)

- Unlike legacy iron-oxide nanoparticle syntheses that rely on nucleation, crystalline growth and ripening, our process stabilizes Fe^{3+} coordination within a non-crystalline yet fully integrated amorphous matrix.
- Over a ~140-minute synthesis window, the coordination environment consolidates without forming long-range order, demonstrating the presence of open-coordination Fe^{3+} sites and confirming that the scaffold locks into a stable amorphous state without the ripening associated with crystal formation

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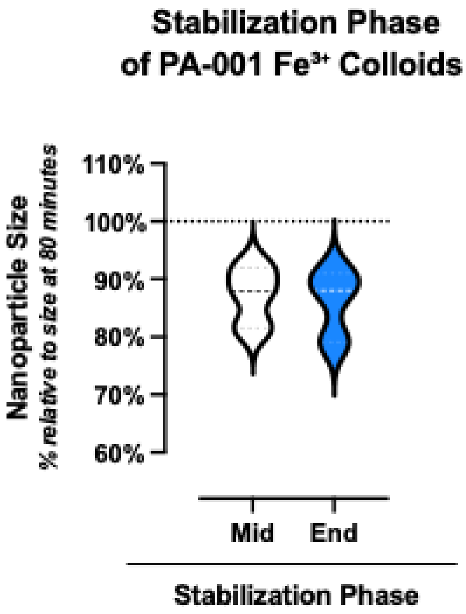
In-process controls indicate self limiting particle formation, with peak size at 80 minutes



Dynamic light-scattering measurements collected across multiple batches during the controlled stabilization (“hold”) phase reveal a reproducible and monotonic decrease in hydrodynamic diameter, consistent with coordination-driven contraction rather than crystal lattice development.

- Particle formation is essentially complete at 80 minutes and at this time, particle size has plateaued
- Diameter decreases during the “hold phase” between 80 and 140 minutes suggesting contraction and structural locking
- This contraction profile represents a controllable, kinetically defined anti-crystalline behavior, characteristic of pre-crystalline amorphous Fe^{3+} colloids. These results provide direct evidence that our process yields structurally locked, non-crystalline nanoparticles with preserved Fe^{3+} accessibility, enabling reliable post-synthetic phosphonate installation under aqueous conditions
- Input reagents are stoichiometrically exhausted

Interpretation:

- Under automatable, one-pot synthesis conditions, multi-dentate iron coordination ligands can govern colloidal stabilization without enforced crystallinity, enabling a standardized iron oxide nanoparticle materials library that expands the available design space for combinatorial discovery as well as downstream therapeutic applications
- The coordination-driven, anti-crystalline behavior creates a structurally stable scaffold that should replicate perfectly across scale, making the process inherently GMP-friendly