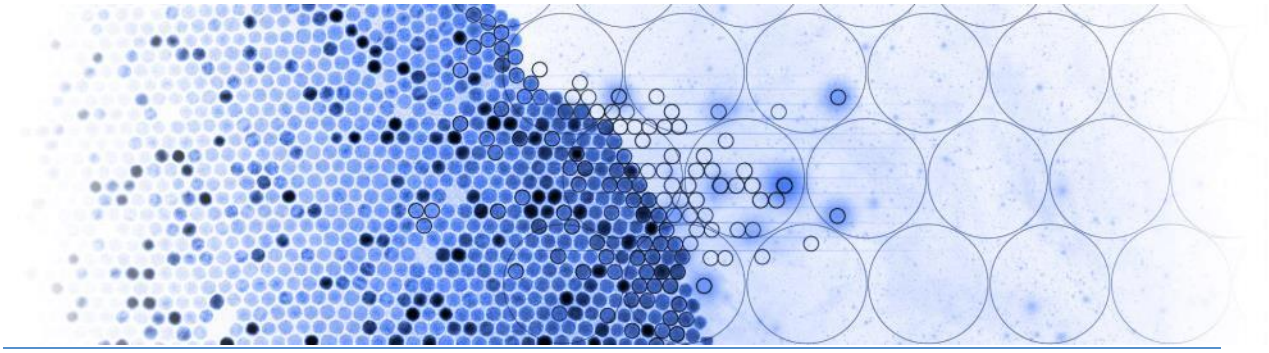

TINY ULTRAMONODISPERSED MAGNETIC NANOPARTICLES

dN4 - TECHNICAL SPECIFICATION SHEET

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1. Description

Product name: dN4

Material composition: Highly crystalline iron oxide magnetic nanoparticles of magnetite crystalline phase (Fe_3O_4), with monomodal and narrow particle size distribution; 4 nm mean size, < 10% dispersion).

Available Solvents: Nanoparticles can be stabilized in aqueous and organic solvent colloidal dispersions:

1. **Aqueous dispersions**. Nanoparticles electrostatically stabilized with tetramethylammoniun hydroxide (TMAOH); pH = 13.
2. **Organic solvent dispersions**. Nanoparticles sterically stabilized with oleic acid in low boiling point solvents (hexane, toluene, chloroform) or in high boiling point solvents (long-chain aliphatic hydrocarbons, long-chain amines, long-chain eters).

Synthesis: Proprietary synthetic method developed and registered by das-Nano. This method ensures the reproducibility of the synthesized nanoparticles in terms of particle shape, size and particle size distribution.

Stability: highly-stable colloidal dispersions over time (minimum 6 months).

Storage: 4-25ºC (do not freeze)

Main physicochemical properties:

- Crystalline phase (determined by electron diffraction): magnetite (Fe_3O_4)
- Particle shape (determined by transmission electron microscopy (TEM)): spherical
- Particle size:
    - Determined by magnetometry (FC-ZFC): 4 nm
    - Determined by TEM (over 2.000 counts): 3.8 nm
- Surfactant / solvent composition:
    - Aqueous dispersions: tetramethylammoniun hydroxide (TMAOH) / water
    - Organic solvent: oleic acid / low boiling point solvents (hexane, toluene, chloroform) or high boiling point solvents (long-chain aliphatic hydrocarbons, long-chain amines, long-chain ethers)
- Concentration: 10 mg Fe_3O_4/ml
- Blocking temperature: 8 K
- Saturation magnetization: 30 emu/g Fe_3O_4

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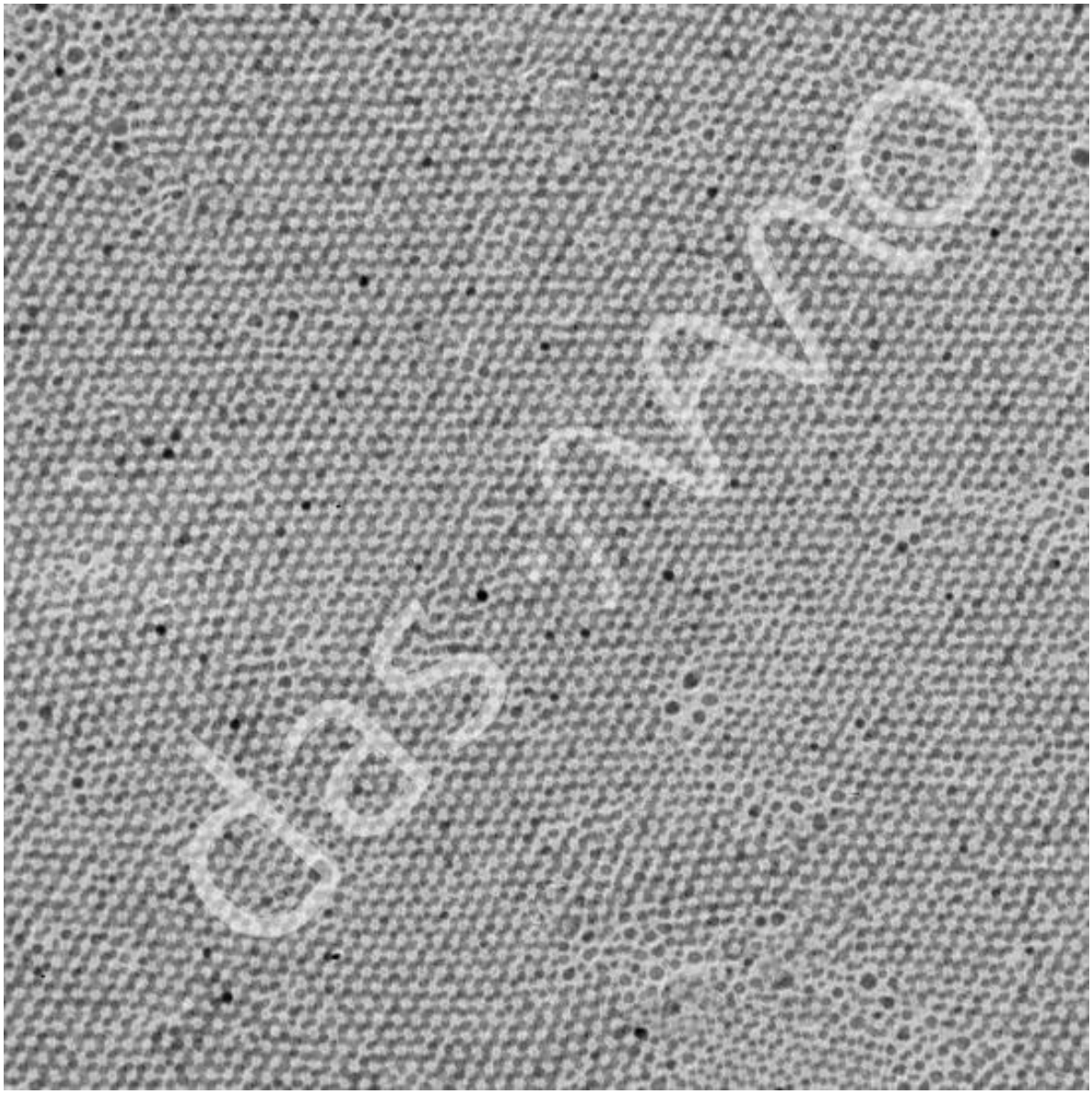
2. Characterization

2.1 TRANSMISSION ELECTRON MICROSCOPY (TEM)

Magnetite nanoparticles are very homogeneous in shape and size (Figure 1).

The hexagonal arrangement shown in the next picture is portraying the outstanding Ultra-Monodispersity of das-Nano's magnetic nanoparticles, with their size centred at 3.8 nm.



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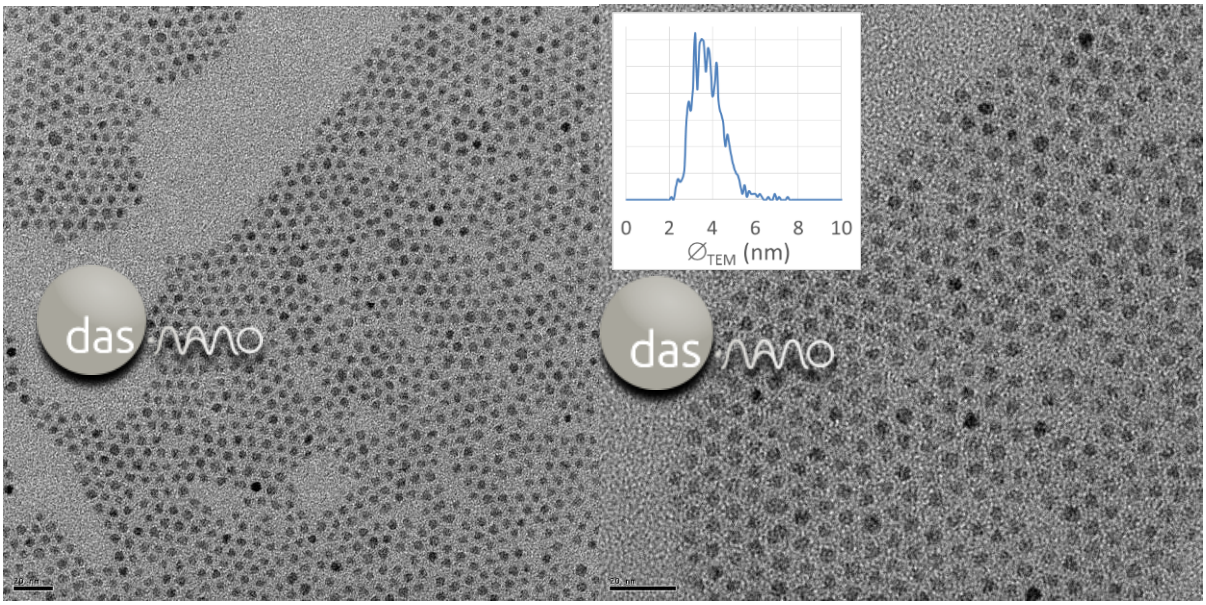

FIGURE 1. TEM IMAGES OF MAGNETITE NANOPARTICLES. SCALE BARS: 20 NM. INSET: PARTICLE DIAMETER DISTRIBUTION DETERMINED BY TEM.

2.2 ELECTRON DIFFRACTION (ED)

Magnetite nanoparticles are highly crystalline (Figure 2). The experimental *d* spacing between adjacent (hkl) lattice planes match 100% the d-values reported for Fe_3O_4 crystalline phase by Okudera, H., Kihara, K. and Mats (1996) in ICSD database (Inorganic Crystal Structure database).

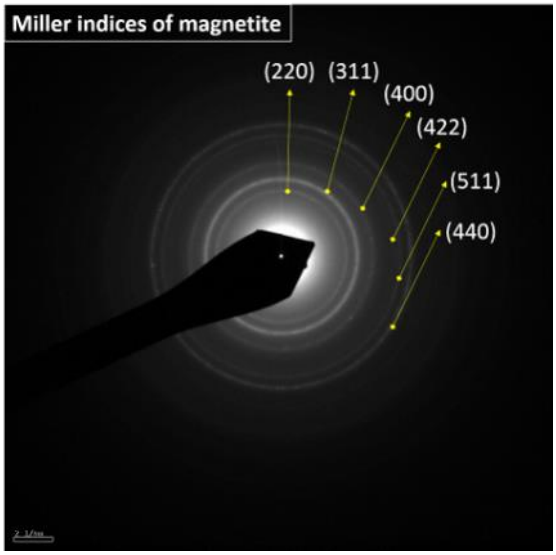

FIGURE 2. ELECTRON DIFFRACTION IMAGE OF MAGNETITE NANOPARTICLES. MILLER INDEXES OF EVERY DIFFRACTION RING ARE NOTED DOWN

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2.3 MAGNETIC MEASUREMENTS

The material is monomodal and superparamagnetic at room temperature (and over 16 K).

Blocking temperature is 8 K.

The mean particle size is 4 nm.

Saturation magnetization is 30 emu/g Fe_3O_4.

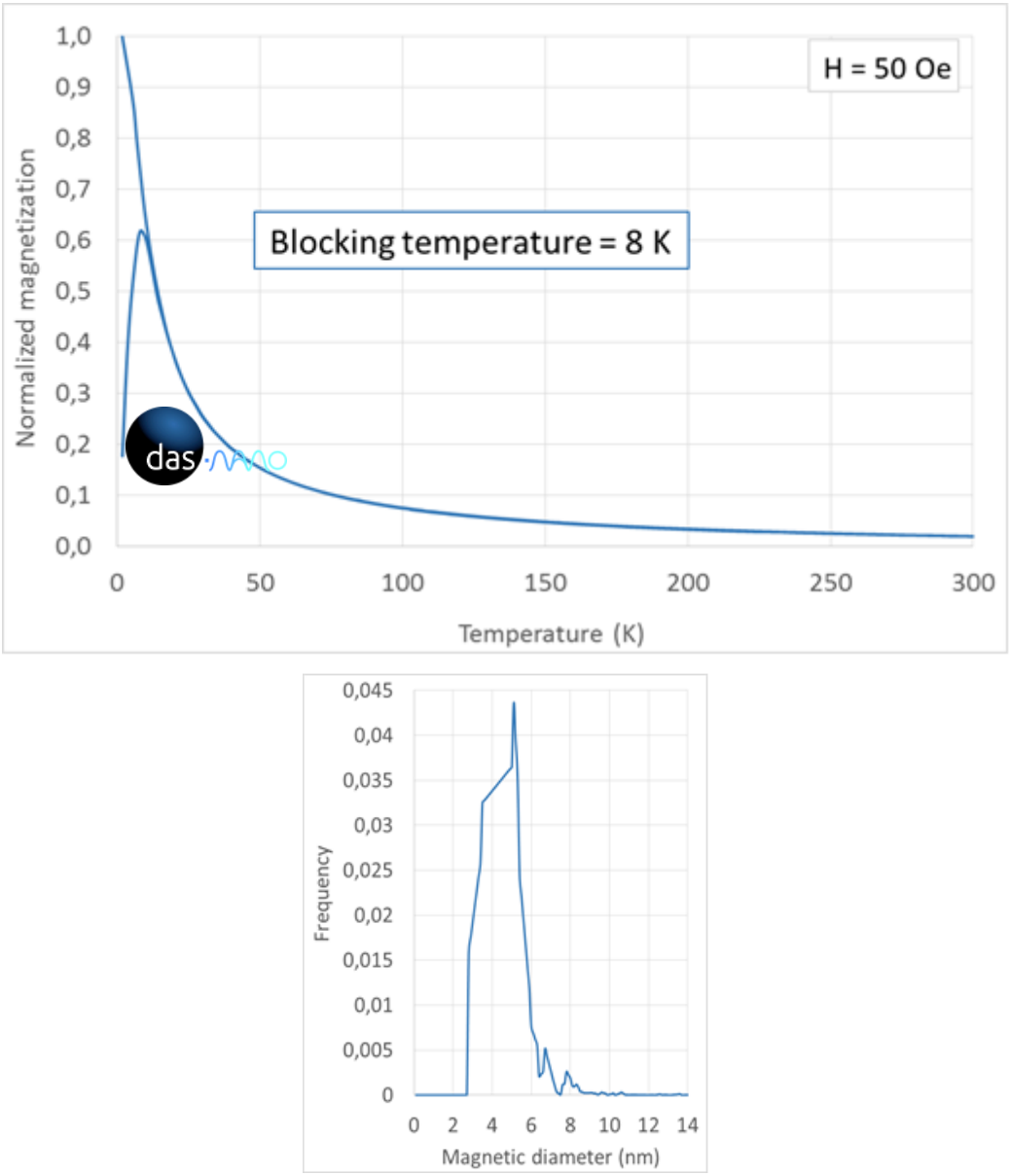

FIGURE 3. ZFC-FC CURVES (ABOVE) AND PARTICLE SIZE DISTRIBUTION CALCULATED FROM THE ZFC-FC CURVES (BELOW).