Technical Data Sheet

(Tetra)Titanium (Hept)Oxide

1. Product Identification

Product name: Ti_4O_7-Conductive Black™

Chemical name: Tetratitanium Heptoxide (Magnéli-phase titanium suboxide)

CAS number: 12065-65-5

Chemical formula: Ti_4O_7

Physical form: Rutile-related crystal structure with crystallographic shear planes; blue-black fine powder

2. Key Technical Properties

Appearance	black fine powder(Blue Shade)
Chemical Form	Magneli
Major Phases	Ti_4O_7
Purity of Ti_4O_7	≥92%
Density g/cm^3	4.3
Heat Resistance	≤600°C
Black Level	≤16
Water Soluble Matter	≤0.5g/ml
Mean Particle Size μm	1～3μm
electrical conductivity (C:Graphite)	2.7C
Light resistance	8
Acid Resistance	8
Alkali Resistance	8

3. Functional Role and Mechanism

Intended Technical Functions

- Highly electrically conductive ceramic oxide at room temperature
- Chemically and electrochemically stable electrode material
- High-opacity black inorganic pigment
- Conductive additive for ceramics and composites
- Solid-lubricant-like filler with layered shear planes

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Mechanistic Description

- Ti_4O_7 belongs to the Magnéli-phase homologous series Ti_nO_{2n-1} (n = 4), derived from rutile TiO_2 via ordered oxygen vacancies along crystallographic shear planes
- Mixed Ti^{3+}/Ti^{4+} valence states create a partially filled d-band, conferring metallic-like conductivity superior to graphite in dense form
- Pauli-paramagnetic at room temperature; essentially non-ferromagnetic
- Strong Magnéli-phase bonding confers high chemical stability in pH 1–14 aqueous media and resistance to electrochemical corrosion

Stability Profile

- Stable in concentrated acids (H_2SO_4, HCl) and strong alkalis (NaOH)
- Acid resistance: 8/8 scale; Alkali resistance: 8/8 scale
- Light fastness: 8/8 (excellent UV/weather resistance)
- Resistant to oxidation in aqueous environments; gradual re-oxidation to TiO_2 occurs above ~500–600 °C in air

4. Application Windows

Compatible Systems

- Electrochemical oxidation anodes and reactive electrochemical membranes (REMs) for water/wastewater treatment (PFAS, organics, ammonia removal)
- Metal electrowinning and electroplating (e.g., manganese, zinc) electrode substrates
- Electrocatalyst supports for fuel cells and electrolyzers (Pt, Pd, Ru catalyst carriers)
- Conductive ceramics and sintering aids in TiO_2-based functional ceramics
- High-end inorganic black pigments (Titanium Black, analogous to PBk.35) for inks, coatings, plastics, and cosmetics
- Solid-lubricant additives in grease and coating formulations

Processing Guidance

- Powder dispersion: Dispersible in water or organic media with appropriate dispersants and surfactants
- Sintering/thermal processing: Maintain inert or vacuum atmosphere above 600 °C to prevent oxidation back to TiO_2
- Electrode fabrication: Can be formed into porous structures, coatings, or bulk monolithic electrodes via spark plasma sintering, cold pressing + sintering, or plasma spraying
- Pigment applications: Standard pigment dispersion protocols; excellent heat resistance up to 600 °C in air for color stability

Typical Use Scenarios

- Dimensionally stable anodes (DSA) and bulk Magnéli-phase electrodes for electrochemical oxidation

- High-performance catalyst supports requiring corrosion resistance and conductivity
- Deep-black pigment for high-opacity, chemically stable coatings and cosmetics
- Conductive phase in ceramic-matrix composites and advanced refractory materials

5. Critical Parameters and Failure Modes

Critical Control Parameters

- Ti_4O_7 phase purity (≥92 wt%): Lower purity reduces conductivity and electrochemical performance
- Particle size distribution: Influences dispersion uniformity, sintering densification, and pigment tinting strength
- Oxygen stoichiometry: Excess oxygen or over-oxidation degrades electrical conductivity and shifts color toward grey-brown
- Processing atmosphere: Air exposure above 500–600 °C causes gradual oxidation to insulating TiO_2

Known Failure Modes

- Thermal re-oxidation: Prolonged heating in air >600 °C converts $Ti_4O_7 \rightarrow TiO_2$, losing conductivity and black color
- Powder agglomeration: Fine particles can agglomerate, reducing dispersion quality and electrode porosity uniformity
- Surface passivation in extreme oxidizing conditions: Very high anodic potentials (>2.5 V vs. SHE) over extended periods may cause minor surface oxidation, though Ti_4O_7 remains far more stable than graphite or carbon anodes

Application Limitations / Exclusion Zones

- Long-term use in air or oxidizing gas atmospheres at temperatures exceeding 600 °C without protective coatings
- Applications requiring electrical insulation (use TiO_2 instead)
- Not recommended as sole structural material; typically used as functional phase, coating, or additive

6. Handling, Storage and Stability

Handling

- Use in well-ventilated areas; avoid dust generation
- Follow standard fine inorganic powder handling practices
- Use appropriate personal protective equipment (PPE): dust mask/respirator (P2/N95 minimum), safety goggles, gloves
- Ti_4O_7 exhibits low acute toxicity but should be treated as a respirable inorganic dust; avoid inhalation

Storage

- Store in a cool, dry place in tightly sealed containers (inner PE/PVC liner; outer kraft paper bag or equivalent)
- Protect from moisture, which may affect powder flowability and dispersion
- Stable under normal ambient conditions; no special temperature control required

Stability

- Chemically stable at room temperature in air and typical storage conditions
- Not self-reactive; no pyrophoric or explosive hazards
- Gradual oxidation occurs only at elevated temperatures (>500 °C) in oxidizing atmospheres

7. Application areas:

Mainly Applied in

- batteries
- ceramics
- chemical, electric metallurgy,
- electroplating and other industries;

Also used in

- water treatment
- anode protection devices
- cosmetics
- printing inks and coatings industries.

8. Regulatory Notes and Disclaimer

- Regulatory status: Ti_4O_7 is not listed as an SVHC, carcinogen (IARC), or mutagen under major international frameworks. Certain pigment grades are formulated for food-contact plastics and cosmetic applications where regional compliance (FDA, EU Cosmetics Regulation, GB standards) has been demonstrated; users must verify regulatory compliance for their specific end use
- Transport classification: Not classified as dangerous goods under ADR / IMDG / IATA when shipped as industrial ceramic/pigment powder
- Health and environment: For complete hazard information, exposure limits, first-aid measures, and environmental data, consult the product-specific Safety Data Sheet (SDS)

Important Note:
This document is a Technical Data Sheet (TDS) and does not replace the Safety Data Sheet (SDS). The information provided reflects typical material properties and is intended for reference only. Users are responsible for evaluating product suitability, process optimization, and regulatory

compliance under their own conditions. No warranty of fitness for any particular purpose is implied.

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