Technical Data Sheet

Basic Copper Hydroxyl Phosphate

1. Product Identification

- Product name: Basic Copper Hydroxyl Phosphate
- Chemical name: Dicopper hydroxide phosphate
- Common name: Copper hydroxide phosphate; basic copper hydroxyphosphate
- CAS number: 12158-74-6
- EC number: 235-285-2
- Molecular formula: Cu_2HO_5P (commonly written as $Cu_2(OH)PO_4$)
- Molecular weight: approx. 239.07 g/mol
- Material class: Inorganic copper(II) hydroxyphosphate (basic copper phosphate–type salt)

2. Short Technical Summary

Basic Copper Hydroxyl Phosphate is an inorganic copper(II) hydroxyphosphate used as a functional additive in selected halogenated polymers, thermoplastics and thermosets. In appropriate formulations it can act as a near-infrared (NIR) absorber and laser-sensitive additive and has been reported to support condensed-phase char formation and reduced smoke in some halogenated polymer systems. Actual performance is highly formulation-, loading- and process-dependent and must be established by the user for each specific system.

3. Material Description & Structure

- Physical form: Crystalline solid, supplied as a fine powder
- Typical appearance: Green to greenish powder; shade depends on particle size and minor impurities
- Crystal system: Orthorhombic copper hydroxyphosphate related to libethenite-type Cu_2PO_4OH structures
- Structural motif: Chains of distorted $CuO_4(OH)_2$ polyhedra linked by PO_4 tetrahedra with bridging hydroxyl groups
- Inorganic type: Copper(II) hydroxyphosphate, structurally related to basic copper phosphates

4. Key Technical Properties

(Representative values – not specifications; grade-dependent)

Property	Typical value / description
Physical form	Green crystalline powder
True density	Approx. 3.6–4.0 g/cm³
Bulk density (loose)	Typically about 0.4–0.6 g/cm³ for fine powders
Particle size (example grades)	Fine powder; mean size often in sub-10 μm range
Solubility in water	Low solubility; practically sparingly soluble at room temperature
Solubility in acids	Slowly dissolves in strong mineral acids with formation of soluble copper salts
pH (aqueous slurry)	Typically near neutral for dilute slurries (approx. 6–8), method-dependent
Loss on ignition / structural water	Usually in the low wt% range (moisture + partial structural water)
Thermal stability	Stable under ambient conditions; maintains hydroxyphosphate structure to several hundred °C before progressive dehydroxylation and transformation to copper phosphates/oxophosphates
Optical properties	Strong visible absorption (green color) and broad absorption in the 600–1500 nm NIR range for Cu_2PO_4OH-type phases

Users should request grade-specific parameters.

5. Functional Role

Potential technical functions (subject to validation in each system):

- Near-infrared absorber and laser-sensitive additive for polymer laser marking and related processes.
- Copper-containing additive that can promote condensed-phase char formation and contribute to reduced smoke in some halogenated polymer formulations.
- Photothermal additive that enables localized heating under NIR irradiation in selected matrices.

Mechanistic concepts (non-guaranteed, system-dependent):

- In halogenated polymers, copper-containing hydroxyphosphates can influence thermal degradation pathways so as to favor char formation and reduce the evolution of combustible volatiles under some conditions.
- Under NIR irradiation, the material absorbs light and converts it into heat; at sufficiently high local energy density, copper centers may undergo partial redox changes (e.g. Cu(II) to lower oxidation states), which in some laser-assisted metallization systems helps generate nucleation sites for subsequent metal deposition.

These effects must always be confirmed by appropriate testing (e.g. cone calorimetry, smoke density measurements, laser marking and metallization trials) in the intended formulation.

6. Application Windows

6.1 Compatible systems (illustrative examples)

- Halogenated polymers (e.g. PVC and other vinyl formulations) for smoke-control and char-promotion studies.
- Thermoplastics used in laser-markable grades, including selected polyolefins, polyesters, polyamides and engineering plastics, where the resulting color and optical properties are acceptable.
- Epoxy and other thermoset systems requiring NIR-induced local heating or laser-assisted structuring.
- Pigmented inks and coatings in which copper content and green coloration can be accommodated and NIR absorption is functionally useful.

Compatibility is formulation-specific and must be verified in each application.

6.2 Process window guidance

- Generally stable under standard polymer processing conditions when bulk melt temperatures are below the onset of significant hydroxyphosphate decomposition and before the host polymer degrades.
- Avoid strong acids and strongly acidic environments during compounding, storage and service where copper leaching or loss of function is a concern.
- For laser applications, commonly used NIR wavelengths include around 800–1100 nm (e.g. 808 nm, 940 nm, 1064 nm). The optimum wavelength, beam profile, power, pulse regime and scanning conditions must be determined experimentally for each formulation and laser system.

6.3 Typical use level / loading range

- Often used at low to moderate loadings, from fractions of a percent up to several weight percent of the total formulation, depending on required marking contrast, smoke/char performance and allowable color.
- Higher loadings enhance NIR absorption and potential response but also deepen the green/blue-green tint, and may influence rheology or mechanical properties.

6.4 Reported and typical application areas

- Component of smoke-suppressant / char-promoting systems for PVC and other halogenated plastics, usually in combination with other flame-retardant and synergistic additives.
- Additive in laser-markable thermoplastic compositions where copper phosphate-type salts (including cupric hydroxide phosphate) are used to absorb laser light outside the visible spectrum and create a contrasting mark.
- NIR-absorbing additive for laser processing and marking of polymers and composites, including ultrashort-pulse laser machining where modified copper hydroxyphosphate surfaces can influence ablation behavior and subsequent metallization.

6.5 Emerging / exploratory applications

- NIR-responsive photothermal agents based on Cu_2PO_4OH architectures with strong and broad absorption between roughly 600 and 1500 nm, used in polymers or hybrid materials.
- $Cu_2(OH)PO_4$-based nanocomposites with carbonaceous phases (e.g. reduced graphene oxide) for photocatalytic or photo-driven processes under visible/NIR light.

These emerging uses are research-oriented and not implied to be validated commercial applications.

7. Application Enabling Mechanisms

7.1 In halogenated polymers

- Supplies copper and phosphate species able to modify dehydrohalogenation and subsequent degradation chemistry in materials such as PVC.
- Can assist in promoting condensed-phase char and lowering smoke yield under some fire test conditions, when used in appropriate formulations with other synergists.

7.2 In laser activation and marking

- Absorbs NIR laser light and converts it to localized heat, enabling color change, darkening, foaming, ablation or surface modification of the polymer matrix, depending on system design and beam parameters.
- In laser-direct structuring and related metallization processes, partial reduction of copper at the surface can provide catalytic sites for electroless metal deposition when suitable plating chemistry is applied.

7.3 As a general NIR absorber

- Provides a photothermal response under NIR irradiation, generating local temperature rises that can be used to support curing, bonding, patterning or surface modification, subject to formulation and process optimization.

8. Critical Parameters

8.1 Loading and dispersion

- Adequate loading and homogeneous dispersion are essential for consistent smoke-suppression behavior, NIR absorption and laser marking response.
- Agglomeration or poor dispersion may cause visible specks, non-uniform coloration and patchy laser activation.

8.2 Laser parameters

- Wavelength must be chosen where the full system (additive, polymer matrix and any pigments) exhibits sufficient NIR absorption.
- Power, pulse duration, repetition rate, focal position, spot size and scan speed must be tuned to achieve the desired effect without excessive thermal damage or loss of mechanical integrity.

8.3 Polymer matrix and environment

- Smoke-suppressing and char-promoting effects in halogenated polymers are sensitive to the complete formulation, including other flame retardants, stabilizers, plasticizers and fillers, as well as the particular fire or heat-exposure scenario.
- In non-halogenated polymers, smoke suppression effects may be limited or require specifically tailored formulations and should not be assumed without testing.
- Environmental pH, presence of chelating agents and water exposure affect copper release and long-term stability.

8.4 Processing temperature

- Processing temperatures should remain within a window where the additive retains its functional structure until the intended trigger event (e.g. fire, laser exposure).
- Users should obtain thermal analysis data (e.g. TGA/DSC) for their specific grade to define maximum recommended processing temperatures.

9. Limitations & Failure Modes

9.1 Known limitations

- Limited or no smoke-suppression benefit in many non-halogenated polymers unless carefully formulated and validated.
- Weak or absent laser marking contrast if additive loading is too low, dispersion is inadequate or laser parameters are not properly adjusted.
- Unwanted green or green-blue tint at higher loadings or certain particle size distributions, which may be unacceptable in color-critical or transparent applications.
- Potential copper leaching under acidic or otherwise aggressive aqueous conditions, limiting suitability for food-contact, potable water or environmentally sensitive applications without thorough evaluation.

9.2 Application exclusion zones (examples)

- Direct food-contact layers and drinking water contact applications, unless specific migration, toxicology and regulatory assessments have been completed and support such use.
- Unprotected outdoor applications where significant runoff and environmental release of copper may occur, without appropriate environmental risk assessment and regulatory management.
- Highly transparent or colorless systems where any visible tint is unacceptable.

10. Application Failure Sensitivities

- Polymer matrices lacking suitable chemistry for char promotion can show minimal smoke-suppression benefit, even at typical additive loadings.
- Using laser wavelengths outside the effective absorption region for the formulated system, or using insufficient power, can produce no visible mark or inadequate functional activation.
- Excessive power density or prolonged exposure can degrade both additive and substrate, causing over-burning, foaming or mechanical damage beyond acceptable limits.
- Poor particle dispersion or non-uniform dosing can lead to inconsistent performance, speckling and variable marking results.

11. Handling, Storage & Stability

(Refer to the product Safety Data Sheet for full safety information.)

11.1 Handling

- Handle with precautions appropriate for inorganic copper compounds.
- Avoid generating and inhaling dust; use suitable local exhaust or general ventilation.
- Avoid ingestion, skin contact and eye contact; wear appropriate personal protective equipment such as gloves, safety goggles and respiratory protection where dust may be present.
- Wash hands and exposed skin thoroughly after handling.

11.2 Storage

- Store in tightly closed containers in a cool, dry, well-ventilated area.
- Keep away from strong acids and incompatible materials.
- Do not store with food, beverages or animal feed.

11.3 Stability

- Stable under normal ambient conditions when stored as recommended.
- No hazardous polymerization is expected.
- Prolonged exposure to strong acids or very acidic environments can lead to dissolution, changes in composition and loss of intended performance.

12. Regulatory Notes

- Substance identity: Dicopper hydroxide phosphate, Cu_2HO_5P, EC 235-285-2.
- As an inorganic copper compound, it may be subject to regulatory frameworks governing copper and its compounds, including environmental emission limits, classification and labelling and workplace exposure considerations.
- Aggregated hazard classifications in public databases for copper hydroxide phosphate frequently include acute and chronic aquatic toxicity alerts and, in some notifications, eye and respiratory irritation; exact classification for a commercial product may vary with purity and formulation and must be taken from the supplier's SDS.
- Users are responsible for ensuring that manufacture, processing, use, transport and disposal comply with all applicable local, national and international regulations, including those relating to copper content and environmental protection.

13. Relationship to SDS / Safety Note

This Technical Data Sheet (TDS) provides technical and application-oriented information only and is not a safety document. It does not replace the Safety Data Sheet (SDS). For detailed information on hazards, first-aid measures, exposure controls, transport classification, disposal considerations and other safety-related topics, always consult the current SDS for this product and all applicable regulations.