

Certificate of the Reference Material

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Name of the Material : Copper (Cu) Standard Solution

Material Code : UME CRM 2216

Issue Date : 09.02.2026

Revision Date : 09.02.2026 (Revision history can be found on the last page)

Validity Period of the Certificate : 18 months from the sales date

Certified Values :

Parameter	Mass Fraction (mg/kg)		Mass Concentration ^[3] (mg/L)	
	Certified Value ^[1]	Uncertainty ^[2]	Certified Value	Uncertainty
Copper (Cu)	999.3	3.7	1013.4	3.7

- [1] The certified value was determined using High-Performance Inductively Coupled Plasma Optical Emission Spectrometry (HP-ICP-OES) and gravimetric solution preparation methods. The certified value and its uncertainty are traceable to the International System of Units (SI).
- [2] The expanded uncertainty of certified value includes characterization, homogeneity, stability components and is stated as the standard uncertainty of measurement multiplied by the coverage factor $k=2$, which for a normal distribution corresponds to a coverage probability of approximately 95 %. The standard uncertainty of measurement has been determined in accordance with GUM "Guide to the Expression of Uncertainty in Measurement".
- [3] The certified value in terms of mass concentration (mg/L) was calculated from the mass fraction (mg/kg) using the measured density value at 20 °C. The uncertainty of the density value was included in the uncertainty of the mass concentration.

Sales Date



Assoc. Prof. Mustafa ÇETİNTAŞ
Director

Informative Values

Parameter	Value ^[1,2]	Uncertainty ^[2,3]	Unit
Density (20 °C)	1014.026	0.044	kg/m ³

[1] The density measurement value was obtained at (20 ± 1) °C at TÜBİTAK UME in accordance with ISO 12185.

[2] The value and its uncertainty are traceable to the International System of Units (SI).

[3] The uncertainty value is the result of multiplying the calculated standard measurement uncertainty by a coverage factor of $k = 2$, which for a normal distribution corresponds to an approximately 95 % confidence level. The standard measurement uncertainty was determined in accordance with the GUM "Guide to the Expression of Uncertainty in Measurement".

Description

The material is a solution prepared by dissolving and diluting high-purity copper metal, followed by homogenization, and then filled into a high-density polyethylene (HDPE) bottle in a volume of approximately 100 mL. The material contains 2 % (w/w) nitric acid (HNO₃). The HDPE bottle is stored inside an aluminum sachet to protect it from light.

Intended Use

This material is intended to be used as a calibration standard for the determination of copper (Cu). It can be used for calibration in Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES), Inductively Coupled Plasma Mass Spectrometry (ICP-MS), Atomic Absorption Spectrometry (AAS), Microwave Plasma Atomic Emission Spectrometry (MP-AES), and other elemental analysis techniques.

Instructions for Use

All necessary precautions should be taken during opening and use of the bottle to prevent contamination and evaporation of the material. The homogeneity of the solution with respect to copper has been demonstrated through both within-bottle and between-bottle homogeneity tests. The minimum sample intake should be determined by the end user based on their measurement capability, taking into account its impact on the uncertainty of the working solution to be prepared. The material can be transported without additional cooling measures, provided that the temperature does not exceed +45 °C and the shipping duration does not exceed two weeks.

Storage Conditions

The material should be stored at (21 ± 3) °C before and after use. TÜBİTAK UME cannot be held responsible for changes that might happen to the material at customer's premises due to noncompliance with the instructions for use, and the storage conditions stated in the certificate.

Safety Information

The material is intended for laboratory use only. General laboratory safety precautions should be followed during the storage and use of the material. It is recommended that the material be used and disposed of in accordance with applicable safety regulations. The Safety Data Sheet (SDS) should be read carefully before using the material.

Participants

The information of the laboratory participating in the characterization study is provided in the table below.

Laboratory	Address
TÜBİTAK UME	TÜBİTAK Gebze Yerleşkesi, Barış Mahallesi, Dr. Zeki Acar Caddesi No.1, 41470 Gebze - Kocaeli / Türkiye

Methods and/or Techniques Used for the Determination of the Certified Values

High-Performance Inductively Coupled Plasma Optical Emission Spectrometry (HP-ICP-OES) and gravimetric solution preparation methods were used in the characterization study.

Revision History

Date	Remarks
09.02.2026	First publication.