

NuMetal[®] Conductive Inks for Printed Electronics

NuMetal[®] ZVNM-009BE Nanocopper Ink – Aqueous dispersion

ZVNM-009BE is a copper metal, oxide-free ink which can be photonically or thermally sintered at low temperature (~150C) post-printing into a highly conductive metallic copper film. The product is designed to produce conductive traces on low temperature substrates. ZVNM-0009BE is specially formulated for compatibility and stability with higher-loading inkjet systems such as those from Dimatix.



PERFORMANCE PROPERTIES

ZVNM-009BE produces, after printing and ~150C sintering, conductive, metallic copper traces with electrical resistivity as low as 2-3x bulk Cu resistivity. ZVNM-009BE is specifically designed for thermal sintering under normal atmospheric conditions could be, but DOES NOT require, photonic curing.

Sample Conductivity

	ZVNM-0009BE	Units
Thin film resistivity	~3 $\mu\Omega$ cm	Micro-ohm-cm
Bulk resistivity comparison	2-3	p (thin film) / p (bulk Cu)

Sample Information

Substrate:	Polyimide (Kapton), PET, Glass slide, spin coated glass slide, Silicon Wafer
Printer:	Dimatix Materials Printer (DMP-3300 Series)
Post-Process Tool:	Hotplate
Environment:	Atmosphere – no special preparation

PHYSICAL PROPERTIES

General Description	Water/organic based crystalline copper nano-particles
Viscosity	9-12 cP
Particle Size	2.3 +/- 1.3 nm 6M mag TEM 934 particles counted
Cu Content	~14-17 wt%

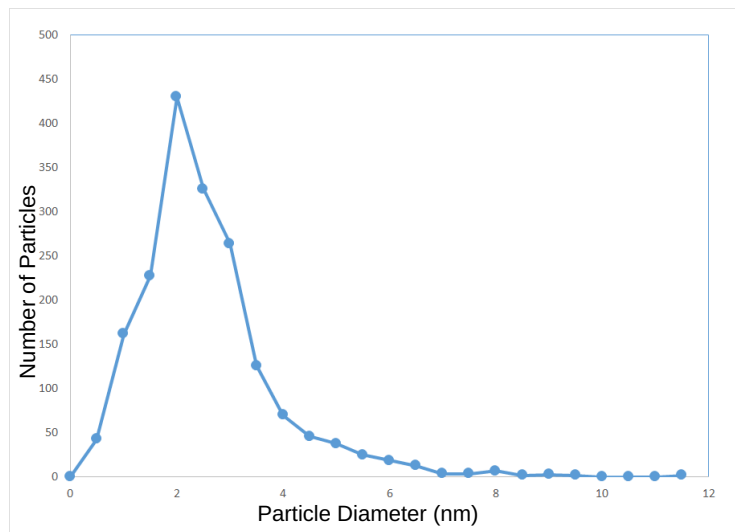
INK PRINTING PROPERTIES

Metal	Copper
Deposition	Inkjet
Curing Methods	Thermal, Photonic and Infrared
Shelf-Life	Excellent stability when refrigerated

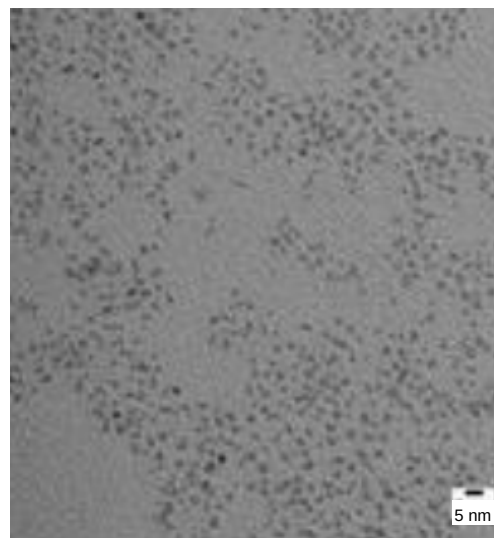
INK CHARACTERISTICS

Surface Tension	~28-34 dyne/cm
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Patent pending ZVNM syntheses have enabled the stable production of transition metals: Ti, Fe, Co, Ni, Cu, Cr, Zn and Sn approaching sizes smaller than 2 nm (about 240 atoms). Nano-metals of this size can be used to overcome print head clogging. Substituting earth-abundant metals such as copper, nickel and zinc instead of using silver in printed circuits offers a new standard of economy and performance. ZVNM has developed the NuMetal family of nano-metal inks for printable electronics manufacturers who want to address a wide range of applications. The metallic inks can be printed via inkjet and upon applying thermal energy convert to metal films/traces that have electrical conductivities close to that of the bulk metal.



Particle Distribution Histogram for NuMetal ZVNM-009BE Nanocopper Ink.
Professor R. Hailstone, Nano-Imaging Laboratory, RIT



TEM of NuMetal ZVNM-009BE Nanocopper Ink 6M X magnification. Average particle size is 2.32 +/- 1.29 nm

About ZeroValent NanoMetals

ZVNM is a materials science company focused on creating and commercializing transformative print media to further advance and enable 2D and 3D metal ink jetting. The print media are nano-particles of the transition metals (Ti, Fe, Co, Ni, Cu, Cr and Zn) and their alloys. These unique materials offer the end user multiple advantages over today's powdered metal technologies such as; far lower sintering temperatures (and thus lower power source requirements which leads to rapid writing and higher throughput), high resistance to aerial oxidation, high tensile strength, and work products with near metal bulk electrical and thermal conductivity.

ZVNM specializes in the area of stable, fully reduced nano-transition metal colloidal dispersions made by facile, economic, scalable, syntheses. ZVNM's expertise lies in mastering the reaction management of uniform, small metal particles (<3nm). We are able to provide metal nano-particles in this challenging size regime through the use of unique solution reaction chemistry coupled with proprietary stabilizing organic (and inorganic) ligand technology.

ZVNM's dedicated and experienced team of management, advisors and staff are committed to providing robust, yet state-of-the art products and service to our customers engaged in the fields of: functional coatings, conductive inks, and additive manufacturing. We are actively seeking collaborations with additive print engine manufacturers, and powdered metals foundries to co-optimize specialty metal inks for their machines.