



NANO DIMENSION

Electrifying Additive Manufacturing®

Materials Datasheet

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1. Introduction

The DragonFly® IV system can print Conductive Ink (CI) and Dielectric Ink 1092 (DI) simultaneously to enable the production of Additively Manufactured Electronics (AME) and Hi-PED (high performance electronic devices). Printing with both inks concurrently while maintaining a high print resolution, the DragonFly® platform has limitless design flexibility in multiple applications and industries. These include communications, RF, medical devices, drones, aerospace, automotive, satellites, in-circuit transformers, antennas, coils, capacitors, inserted components and more.

2. Dielectric Ink 1092 - Dielectric UV Curable Acrylate Ink

Winner of the [IDTechEx Technical Development Materials 2018 Award](#), the Nano Dimension dielectric ink, Nano Part # CSA-000014, NND-MAT-DI-003, is designed to complement conductive AgCite® nano-silver ink and provide essential electrical insulation, including when printing at or below a thickness of one hundred microns. The ink contains excellent, uniform dielectric properties that have so far been tested up to a frequency of 65GHz, thus enabling a variety of applications in the electronic market from DC to RF.

Table 1 shows the dielectric constant (Dk) and the tangential loss (Df) as a function of frequency. These measurements were taken using a SPEAG DAK-TL3.5-P contact probe beam on the surface at 22±3°C.

| Frequency | 200MHz | 1GHz | 2.5GHz | 5GHz | 7.5GHz | 10GHz | 30GHz | 40GHz | 50GHz | 65GHz |
|--------------------------|--------|-------|--------|-------|--------|-------|-------|-------|-------|-------|
| Dielectric Constant (Dk) | 2.96 | 2.89 | 2.85 | 2.83 | 2.81 | 2.80 | 2.83 | 2.82 | 2.82 | 2.81 |
| Tangential loss (Df) | 0.034 | 0.026 | 0.018 | 0.018 | 0.021 | 0.021 | 0.016 | 0.016 | 0.016 | 0.014 |

Table 1 - Dielectric properties: Dk and Df as functions of operational frequencies

| | DI 1092 | Unit | Condition | Test Method* |
|--|----------|-------------------|----------------------------------|----------------------|
| Dielectric breakdown (Thickness 1.6mm) | 41.7 | kV | | IPC-TM-650, 2.5.6 |
| Volume resistivity | 7.07E+09 | MΩ•cm | After humidity conditioning | IPC-TM-650, 2.5.17.1 |
| Surface resistivity | 6.67E+09 | MΩ | After humidity conditioning | IPC-TM-650, 2.5.17.1 |
| Arc resistance | 134 | Sec | | IPC-TM-650, 2.5.1 |
| Dimensional Stability | 99.9 | % | After thermal stress (4h, 105°C) | IPC-TM-650, 2.4.39 |
| Moisture absorption | 1.30 | % | | IPC-TM-650 2.6.2.1 |
| Tensile strength | 63 | MPa | 23 °C | ASTM D638 |
| | 58 | MPa | 23 °C | ISO 527 |
| Elongation at break | 10 | % | 23 °C | ASTM D638 |
| | 7 | % | 23 °C | ISO 527 |
| Elastic Modulus | 2.4 | GPa | 23 °C | ISO 527 |
| Flexural strength | 106 | N/mm ² | 23 °C | IPC TM-650 2.4.4 |
| Flexural Modulus | 2.2 | GPa | 23 °C | IPC TM-650 2.4.4 |
| Impact Resistance (notched) | 13 | J/m | 23 °C | ASTM D256 |
| | 16 | J/m | 23 °C | ISO 180 |
| CTE (TMA) (thickness ≥ 0.5 mm) | 136 | ppm/°C | 35°C-230°C, no pretreatment | IPC-TM-650 2.4.24 |

| | DI 1092 | Unit | Condition | Test Method* |
|---|-----------------|-------------------|---|------------------------------|
| | 103 | ppm/°C | 35°C-120°C, pretreatment: 105 °C, 2 h | |
| | 133 | ppm/°C | 35°C-230°C, pretreatment: 105 °C, 2 h | |
| Decomposition temp. (Td 2%) (TGA) | 309 | °C | | IPC-TM-650 2.4.24.6 |
| Decomposition temp. (Td 5%) (TGA) | 351 | °C | | |
| Tg (DMA, 10 Hz, tan delta) | 145 | °C | | IPC-TM-650 2.4.24.4 |
| Thermal conductivity | 0.181 | W/mK | 25 °C | ASTM E1530-19 |
| | 0.200 | W/mK | 120 °C | |
| | 0.220 | W/mK | 200 °C | |
| Density | 1.18 | g/cm ³ | 23 °C | ASTM D792 |
| Roughness (Ra) | <2.5 Top | µm | | IPC-TM-650, Method 2.2.22 |
| | <0.25 Bottom | µm | | |
| %TML (outgassing) | 0.49 | % | | ASTM 595-15 |
| %CVCM (outgassing) | <0.01 | % | | ASTM 595-15 |
| %WVR (outgassing) | 0.24 | % | | ASTM 595-15 |
| Note: Test methods are used as a reference for the testing methodology only. The IPC specifications for PCBs do not apply to AME technology. | | | | |

Table 2 - Physical, thermal and electrical Properties

Safety & Handling

Read and practice the safety guidelines described in: [Dielectric Ink 1092 MSDS](#).

3. AgCite® 90072 Silver Nanoparticle Conductive Ink

Winner of the [IDTechEx Technical Development Materials 2018 Award](#), AgCite™ conductive ink (Nanoparticle Silver Ink, Nano Part # CSA-000013, NND-MAT-CI-002) is based on pure silver particles that have controlled characteristics such as shape and particle distribution. This ensures that each batch of AgCite™ nano-silver ink is suitable for a wide range of additive manufacturing for electronic applications, while maintaining excellent conductivity and adhesion. Furthermore, unlike regular metal powders that require high sintering temperatures, AgCite™ nano-silver inks can achieve a sintering temperature low enough for compatibility with Nano Dimension's dielectric Ink.

| | | |
|--|--|---|
| Conductivity (silver nano particles) * (S/m) at 20 °C] | $2.21 \times 10^7 \pm 0.95 \times 10^7$ | Printing & sintering conditions dependent |
| Max reflow solder temperature [°C] ** | 165 | Using: Quick Chip TS391LT (138°C***)/ KOKI TB48-M742 (138°C***) Paste. |
| Max manual soldering temperature [°C] ** | 220 | |
| Roughness Ra | Top surface <2µm, Bottom surface 0.25µm | IPC-TM-650, Method 2.2.22 |
| Elementary analysis after sintering [%wt] | Ag: 96.1, C: 3.9 | EDS (Energy Dispersive X-ray Spectroscopy) (Oxford) (Detection limit: 0.5%) |
| * Bulk silver conductivity = $6.30 \times 10^7 \sigma$ (S/m) at 20°C | | |
| ** Refer to Manual Soldering of DragonFly AME Devices application notes. | | |
| *** Melting temperature per vendor's specification. | | |

Table 4 - Physical, thermal, and electrical Properties

Safety & Handling

Read and practice the safety guidelines described in [AgCite® 90072 MSDS](#).

4. Reliability



IMPORTANT

The Hi-PEDs were submitted to reliability tests based on IPC-650 and passed successfully:

- IST (Interconnect Stress Test) over 300 thermal cycles in the range of RT (Room Temperature) to 100°C.
- HATS (Highly Accelerated Thermal Shock) over 500 thermal cycles in the range of 0 to 70°C.
- Mechanical shock (TM 2.6.5) and Vibration (TM 2.6.9) (Hi-PED dimensions: 80 x 60 x 1.6 mm³)

5. Stability

Hi-PEDs can be stored in a zipped bag - conductivity is guaranteed for up to 6 months.



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