

# AG Nano System LLC -Technical Report



The **Nano-silver plating metal** is a cluster of silver and thiolate and has a matching analog in gold in terms of the number of metal atoms, ligand count, super-atom electronic configuration, and atomic arrangement and has optical, electronic, physical, and chemical properties as gold. **The traditional gold electroplating system will be replaced by the Nano-Silver plating produced by a new electrodeposition process using [Ag<sub>25</sub>(SR)<sub>18</sub>]- the "Golden" Silver Nanoparticle compound.**

The electroplating process will produce golden silver Nano-plating that meets the same standards as traditional gold plating, such as Mil-G-45204, DTL-45204, and ASTM B-488. The product will be of the highest quality and made from raw materials that have been scientifically proven.

The Nano-silver plating will be beneficial for end-use industries as:

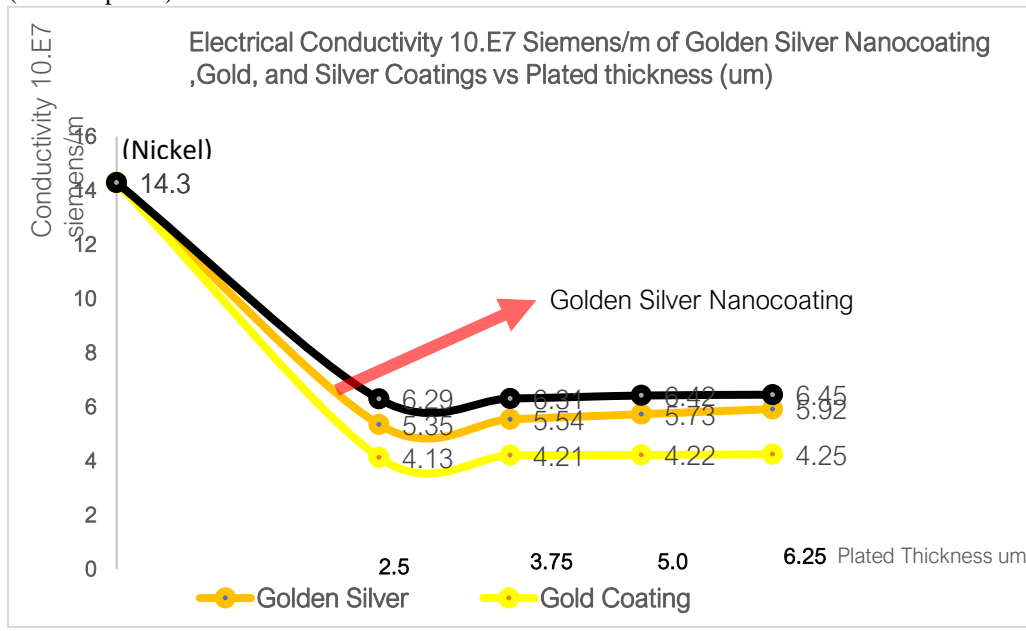
- It can acquire the properties and appearance of gold plating.
- The silver electroplating process is at least **3 to 4 times less expensive than the gold electroplating process.**
- The method meets traditional gold plating standards such as **Mil-G-45204, DTL-45204, and ASTM B-488.**

## Technical Data-Product Features -RESULTS

Technical properties and certified data of golden silver nanoparticles plating material, plated by AG Nano System LLC:

- **Electrical Conductivity Data**

(The Graph #1)



The Golden Silver Nano-plating material has better conductivity than the gold-plated layer

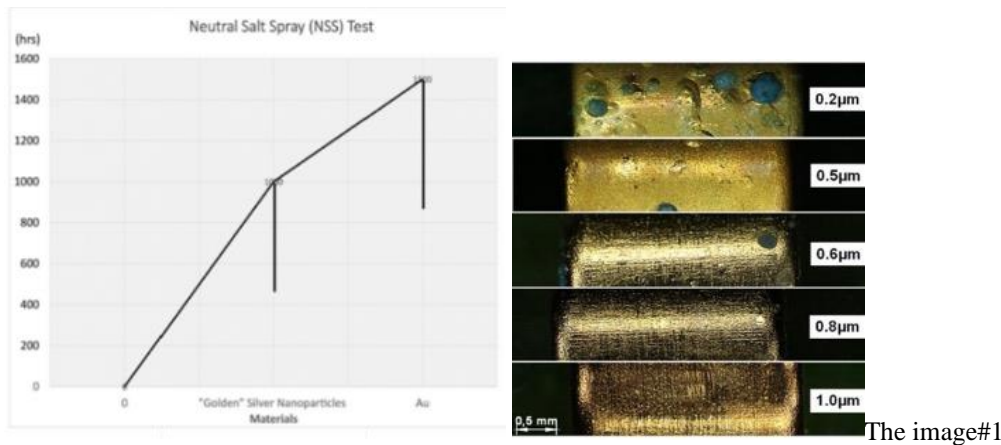
- **Hardness (Knoop's)**

The Knoop hardness test method is a micro hardness test for mechanical hardness, particularly for very brittle materials or thin sheets, where only a tiny indentation may be made for testing purposes.

Table#1

Test	Gold Electroplating Standard	Golden Silver Nanoparticles Coating
Knoop Hardness (HK <sub>25</sub> )	120 to 200 HK <sub>25</sub> (Grace C)	(130) 120-200 HK <sub>25</sub>
ASTM B117 neutral salt spray test on a 100-microinch coating	1000 hours before onset of corrosion	1000 hours before onset of corrosion

- **Corrosion**



**Test-Neutral Salt Spray Test Per ASTM B117 -Golden Silver Nano-Coating material**

- The graph shows **no tarnish or corrosion** –pass 1000H Salt Spray Test per ASTM B117
- Th image shows **no corrosion spots** on the golden silver nanoparticles plating with a thickness of 0.8 μm and 1.0 μm

- **Contact Resistance**

The contact resistance of golden silver nanoparticles plating shows similar results as gold plating contact resistance (meager). The test was performed with different plating thicknesses (0.10 μm, 0.8 μm, 2.5 μm) and confirmed the assumption that the contact resistance of plating increases with increasing thickness.

- **Thermal Conductivity**

The Golden silver nanoparticle’s plating provides outstanding thermal conductivity. The relationship is linear, but it breaks down at low temperatures. Comparing the thermal conductivity of gold plating (318 W/(m·K)) and silver plating (429 W/(m·K)), the conductivity for golden silver nanoparticles plating will be slightly lower (400 W/(m·K))

- **Adhesion**

The tape **test** was used to determine if the **plating** had inferior **adhesion**. The **test** was run on a clean, dry surface by pressing a **tape** with a strong **adhesive** firmly onto the surface and then snapping off the **tape** as fast as possible. The unique tape (**Permacol 99**) was used to perform this test per ASTM D3359. The positive result showed extreme adhesion to the substrate without layers separation.

- **The invented non-cyanide electrolyte**

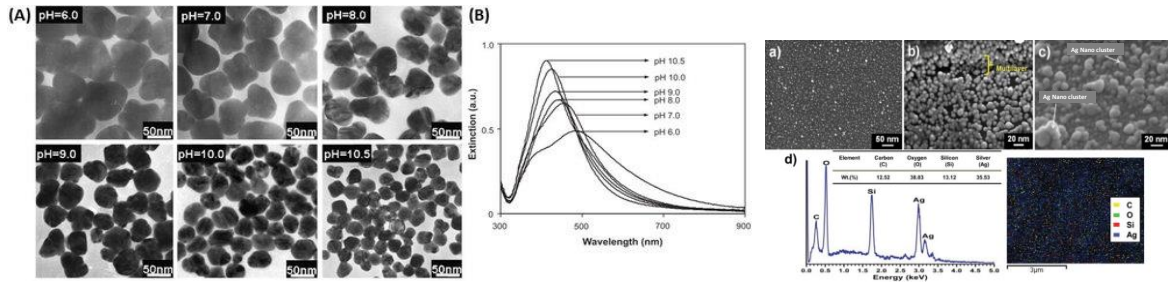
Most plating of gold and its alloys is carried out from solutions containing gold as a soluble cyanide complex. However, “golden” silver nanoparticle solution is formulated at **pH 5.0 +/-0.5** and does not contain cyanide complex. The technology is eco-friendly and does not need special treatment for cyanide chemicals. The presence of the Ag25 golden silver nanoparticles cluster was determined after plating by measuring the absorption spectra (UV-vis) in the electrolyte solution with the repeatable results of **675nm**. The composition of the plating deposits (advance material) was also tested by XRF with the following results

Element	Weight %	
	CORE	COAT
Cu	> 99%	53.51%
Zn	< 0.5%	< 0.02%
Ag	< 0.01%	6.76%
Au	< 0.01%	1.10%
Ni	< 0.01%	38.61%

The composition of the golden silver coating (Table #2)

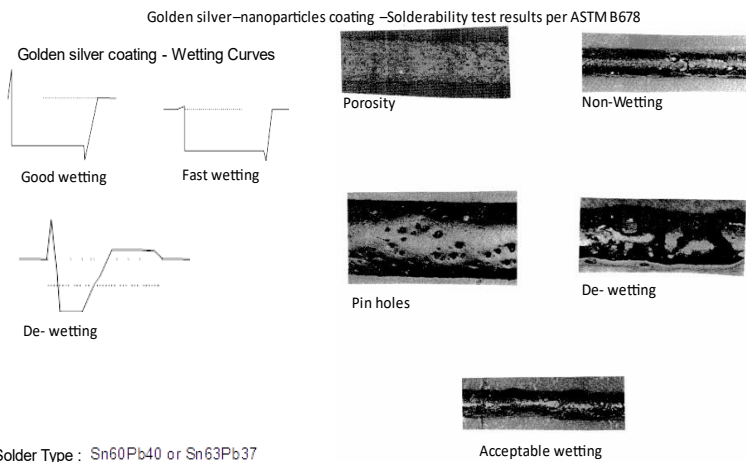
- **The amorphous structure of grains size of golden silver nonparticipants material**

The image #2 below shows TEM images of plated golden silver nanoparticles material with SEM high resolution.



The average size of the nanoparticles, confirmed by TEM and SEM imaging, ranges from **20-60 nm**.

- **Solderability tests results for Golden Silver Nanoparticles material**



The Image #3 present the solderability test for golden silver material performed per Mil-STD-202 with the following acceptance criteria: Failure Criteria 5% maximum dewetted, nonwetted, or with pin holes. All passed.