Invar Chemicals and Films

NANO3D provides Nickel-Iron electroplating chemicals as well as INVAR foils and films deposited on different substrates.

Key Benefits:

- **Superior process chemicals**

Stabilized electroplating solutions preventing the oxidation of iron with proprietary stress-reducer and wetting agent to produce superior INVAR films and foils.

- **Low internal stress**

INVAR films with low internal stress of ~ 30 MPa.

- **Low surface roughness**

Smooth and uniform INVAR films with average surface roughness of Ra ~ 2 nm over a 25 by 25 μm surface area, with well controlled thickness uniformity of 5% @ 1 σ.

- **Controlled thermal expansion**

Thermal expansion coefficient as plated INVAR films as low as $0.41 \pm 0.05 \times 10^{-6}\ K^{-1}$.

- **High thermal conductivity**

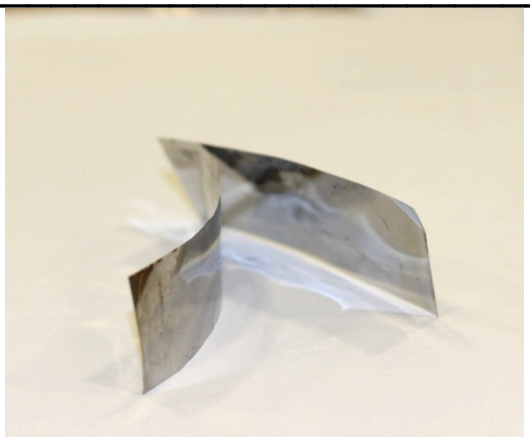
Specific heat of about 0.52 (J/g K) at 573 K. Plane thermal conductivity as plated INVAR of about 43 (W/mK).

- **Low defects**

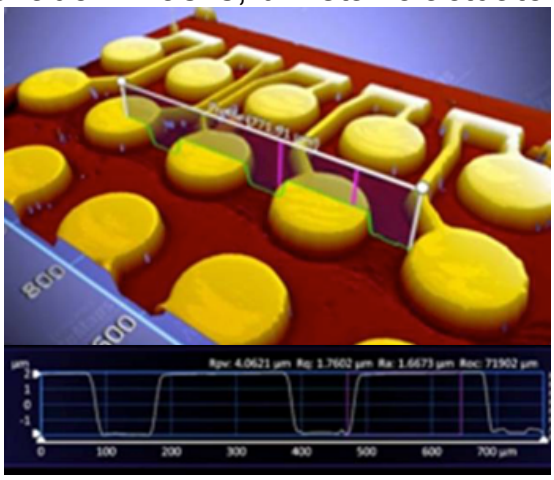
Ultrathin (down to 5 μm) pinhole-free foils and films.

- **Controlled electrical resistivity**

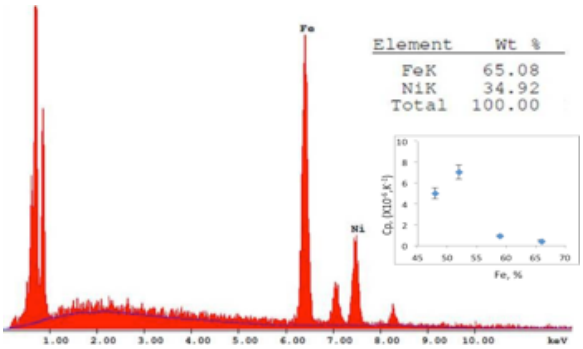
Resistivity can be regulated.



Controlled expansion alloy films for shadow masks, bimetallic actuators



Smooth and uniform patterned INVAR films



Energy Dispersive X-ray Spectroscopy of INVAR films. The insert shows linear thermal expansion vs concentration of Fe% in INVAR films.

Invar Chemicals and Films

INVAR Thin-Film Products

Ultrathin & pinhole-free foils and films deposited on various substrates (silicon, glass, polymers, copper and other metals) in full film or custom cut sizes with superior properties according to NANO3D specification.

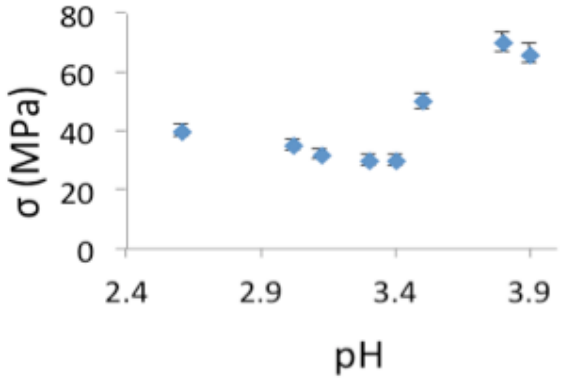
- Thickness: 5 µm; 10 µm; 15 µm; 20 µm
- Products size: 25x50 mm and 50x50 mm

Properties of Ni-Fe Foils & Films	NANO3D Specification
Density (g/cm^3)	8.1
Specific heat capacity (J/gK) at 573 K	0.52 ± 0.05
Thermal conductivity in plane (W/mK)	43 ± 5
Linear thermal expansion (10^{-6}, K^{-1})	0.41 ± 0.1
Internal stress (MPa)	30 ± 2
Young's modulus (GPa)	42 ± 10
Yield strength (MPa)	280 ± 50
Tensile strength (MPa)	500 ± 60
Ductility (%)	40 ± 10

INVAR Chemical Products

- **Nickel –Iron electrolytes**
- **Plating additives**
  - Wetting Agent
  - Stress Reducer
  - Stabilizer

Plating solution ingredients & conditions (pH, Temp., flow) are optimized to achieve superior performance.



Stress vs pH in Ni-Fe plating bath

- **Metrology reagents and standards**
  - Reagents for Bath Metrology
  - Electrolyte Calibrations Standards (LSL, Target, USL)
  - Additive Calibration Standards (LSL, Target, USL)

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