



SEM Lab, Inc. provides ...

Technical consulting services

Failure analysis services

Scanning electron microscopy (SEM) services

... with a focus on electronic materials and processes

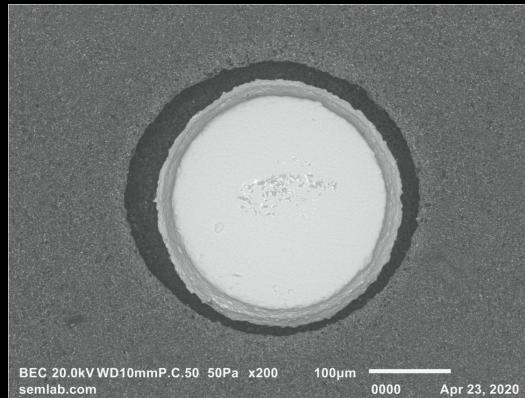
ENIG Gold Thickness

**Estimate gold thickness on ENIG finished PWB
features based on ZAF quantification of EDS data?**

ENIG Gold Thickness

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BSE SEM image

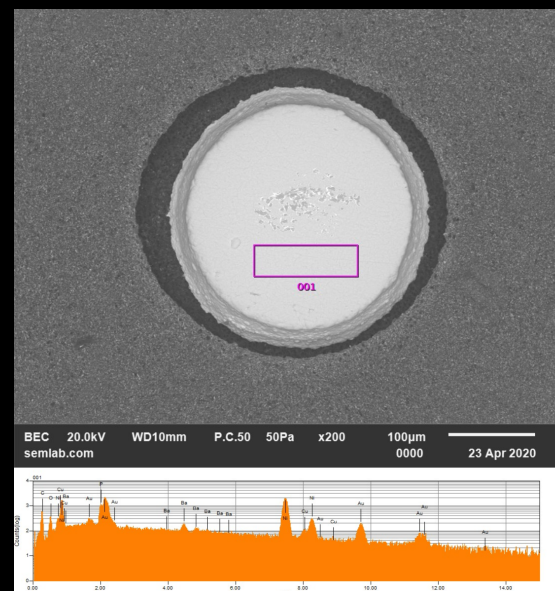
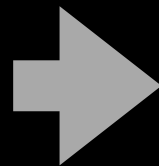
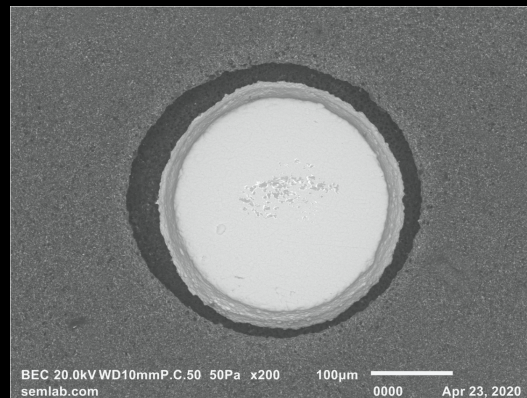


ENIG Gold Thickness

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EDS raster scan & spectrum

BSE SEM image

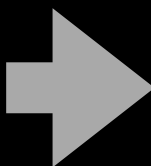
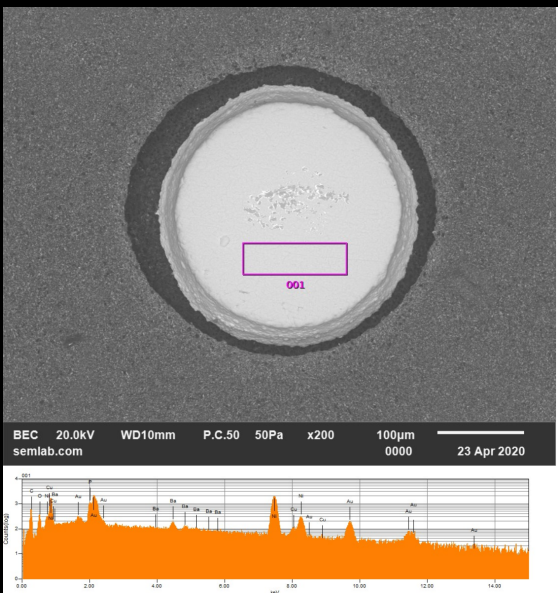
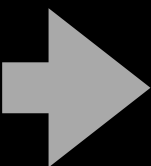
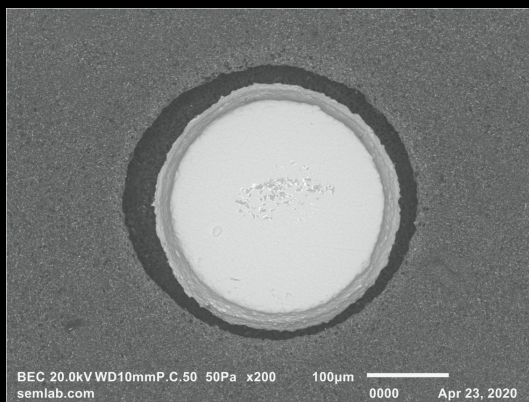


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Quantified EDS data

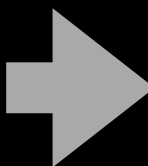
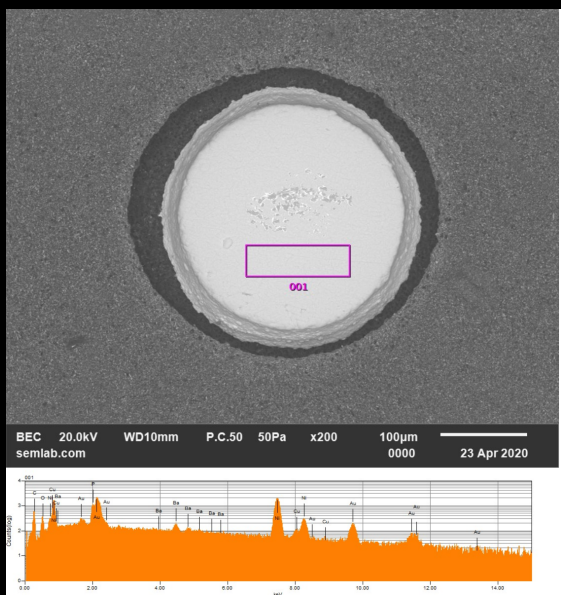
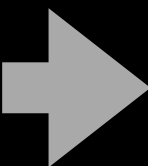
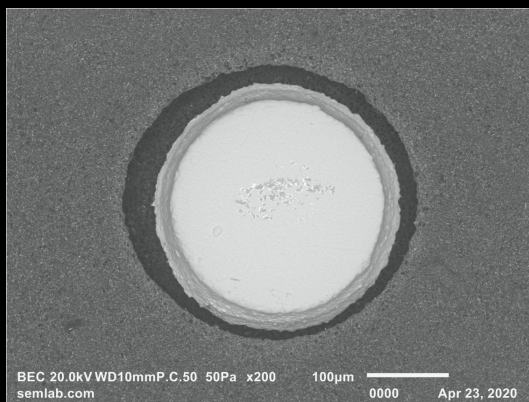
Formula	mass%	Atom%
C	3.72	37.74
O	0.97	7.35
P	1.75	6.88
Ni	18.84	39.12
Cu	0.64	1.23
Ba	0.89	0.79
Au	11.12	6.88
Total	37.92	100

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Estimate gold thickness on ENIG finished PWB features based on ZAF quantification of EDS data?

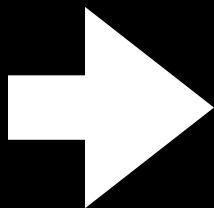
EDS raster scan & spectrum

BSE SEM image



Quantified EDS data

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ENIG Gold Thickness = 0.103 microns
wt% P in EN = 8.5%

ENIG Gold Thickness

Tool Development ...

- **Python 3.13.2**
- **Scientific Computing: NumPy, SciPy**
- **Data Processing: Pandas**
- **User Interface: Streamlit**
- **Physics: XrayLib**

ENIG Gold Thickness

User Interface ...

Run Fit

Preset stack

ENIG_Au_on_NiP_... ▾

Elements of interest (used in SSE)

No options to select ▾

> Weights (optional)

Run Fit

Deploy ⋮

EDS Thin-Film Thickness (20 keV)

Paste ZAF-quantified EDS tables → select stack → choose elements of interest → fit thickness.

▾ Paste ZAF table (CSV or whitespace)

Paste here

Element, mass%, Atom%, Sigma, Net, ...
Al, 14.6, 18.8, ...
Si, 10.3, 12.7, ...

Parse → DataFrame

Clear

Assumptions: 20 keV ZAF quantification; selected elements are normalized to 100% before fitting. NIP density & composition follow your law: $p = -10 \cdot \text{wt\%P} + 8.9$, $\text{wt\%P} = P / (\text{Ni} + P)$. Densities & stoichiometries come from presets unless overridden by NIP rule.

Ed Hare /ehare@semlab.com

 SEM Lab, Inc.

ENIG Gold Thickness

Simply paste EDS data here ...

Run Fit

Preset stack

ENIG_Au_on_NiP_... ▾

Elements of interest (used in SSE)

No options to select ▾

> Weights (optional)

Run Fit

Deploy ⋮

EDS Thin-Film Thickness (20 keV)

Paste ZAF-quantified EDS tables → select stack → select elements of interest → fit thickness.

▼ Paste ZAF table (CSV or whitespace)

Paste here

Formula	mass%	Atom%
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O	0.97	7.35
P	1.75	6.88
Ni	18.84	39.12
Cu	0.64	1.23
Ba	0.89	0.79
Au	11.12	6.88
Total	37.92	100

Press ⌘+Enter to apply

Parse → DataFrame

Clear

Assumptions: 20 keV ZAF quantification; selected elements are normalized to 100% before fitting. NiP density & composition follow your law: $p = -10 \cdot \text{wt\%P} + 8.9$, $\text{wt\%P} = P / (Ni + P)$. Densities & stoichiometries come from presets unless overridden by NiP rule.

... and press parse button

ENIG Gold Thickness

Select elements e.g. Au, Ni, P ...

Run Fit

Preset stack

ENIG_Au_on_NiP... ▾

Elements of interest (used in SSE)

P × Ni ×

Au × ▾

> Weights (optional)

Run Fit

Parsed Table

Formula	mass%	Atom%
C		37.72
O		7.35
P		6.88
Ni		39.12
Cu		1.23
Ba		0.79
Au		6.88
Total	37.92	100

NiP updated from measured Ni/P → wt%P=8.50%, ρ_NiP=8.050 g/cm³

Selected elements sum to 83.60% → normalized to 100% for fitting

Thickness (nm)

```
{
  "Au" : 102.97872100205333
  "NiP" : 500
}
```

Uncertainty (nm)

```
{
  "Au" : NaN
  "NiP" : NaN
}
```

Residuals (wt%)

```
{
  "P" : 1.7763568394002505e-15
  "Ni" : 0
  "Au" : 0
}
```

SSE

0.000000

... and press <Run Fit> button

ENIG Gold Thickness

Future development ...

- add module for Al/Ti-W/SiO₂/Si₃N₄ on semiconductors
- add module for optical coatings on SiO₂
- add module for user customized stacks



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