
Scanning Electron Microscopy (SEM) Analysis

Polyfuze™ Graphics Corporation



Analysis Conducted for Polyfuze™ Graphics Corporation by:
Advanced MicroAnalytical Laboratory
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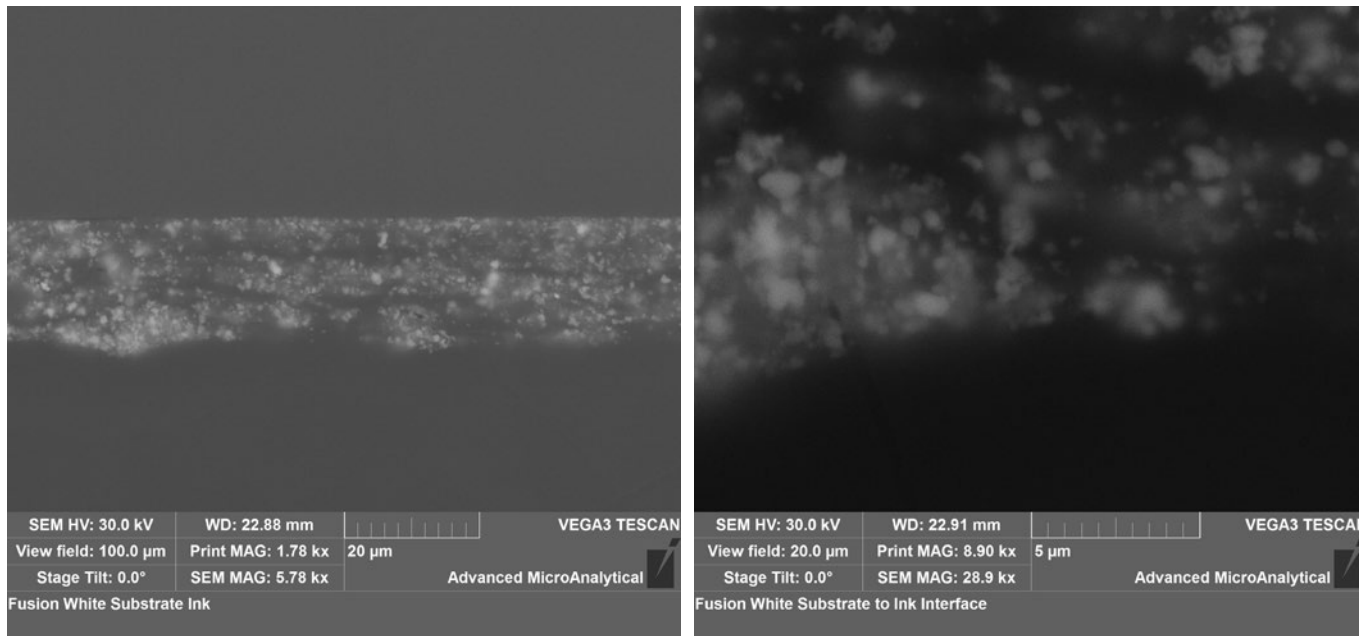
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About Advanced MicroAnalytical

Advanced MicroAnalytical provides solutions to complex problems involving materials analysis from the identification of unknown materials to product viability and quality control on a vast array of sample sources and types.

SEM analysis provides detailed, high resolution imaging capabilities at a very wide range of magnifications from 10x to 1Mx magnification on a diverse and large group of sample types. This flexibility, as well as the dynamic, high depth of field images obtained with this analysis makes it a go-to method to gain structural insight on a wide range of sample types.

SEM relies on the detection of high energy electrons emitted from the surface of a sample after being exposed to a highly focused beam of electrons from an electron gun to produce a magnified image for analysis. This beam of electrons is focused to a small spot on the sample surface, using the SEM objective lens to collect image data.



Example of SEM Analysis at 100.0 μm Magnification (left) and 20.0 μm Magnification (right) performed on Polymer Fusion Labeling cross section.

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Label Sample Preparation:

All label samples analyzed are sold as “permanent labels” for durable products and components manufactured from polyolefin thermoplastics.

For this analysis, each label was applied to High Density Polyethylene (HDPE) Test Plaques using the specified application technique, cross-sectioned using scalpel cuts, cleaned (essential for image clarity) and encapsulated in Epoxy Resin (preserving materials permanently preventing deterioration and/or damage to the material surface).

Subjects were then dehydrated to remove remaining moisture, polished, and adhered to mounting surface for SEM Analysis.



Label Cross Section within Mounting Surface for SEM Analysis

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Label SEM Analysis Conducted On:



Analysis 1 - In Mold Labeling (IML)



Analysis 2 - Hot Stamp Foil



Analysis 3 - Pressure Sensitive Adhesive (PSA)



Analysis 4 - Polymer Fusion Technology

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Solving Problems One Label At A Time

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Analysis 1 In Mold Label (IML) Construction

Applied to Injection Molded HDPE Test Plaque

- Construction Cross Section Imaging (20x and 50x)
- Construction SEM Magnification (49.8 μm)



IML Label Cross Section within Mounting Surface for SEM Analysis



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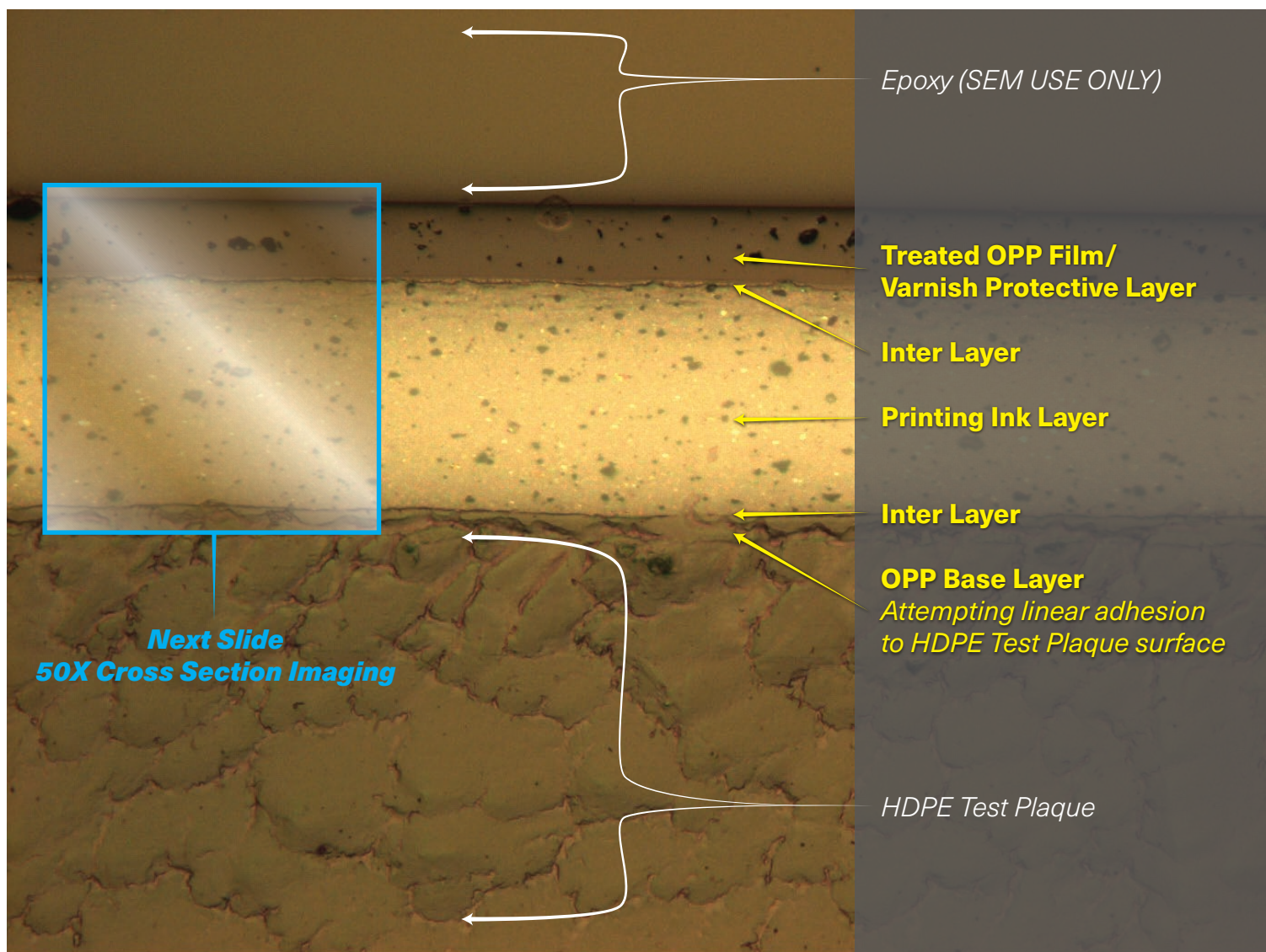
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Analysis 1 In Mold Label (IML) Construction

- 20X Cross Section Imaging
(5 Construction layers observed)

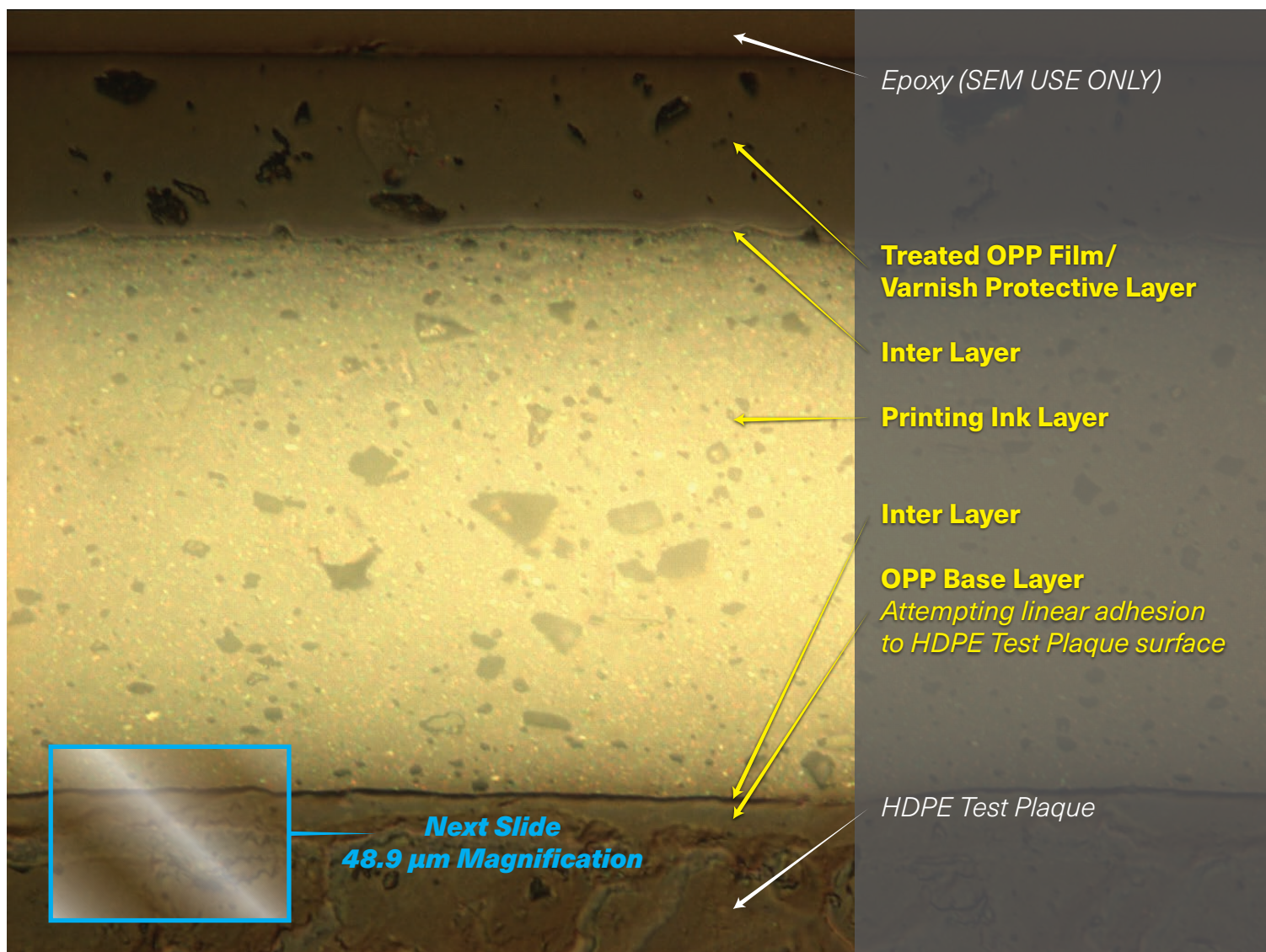


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Analysis 1 In Mold Label (IML) Construction

- 50X Cross Section Imaging
(5 Construction layers observed)

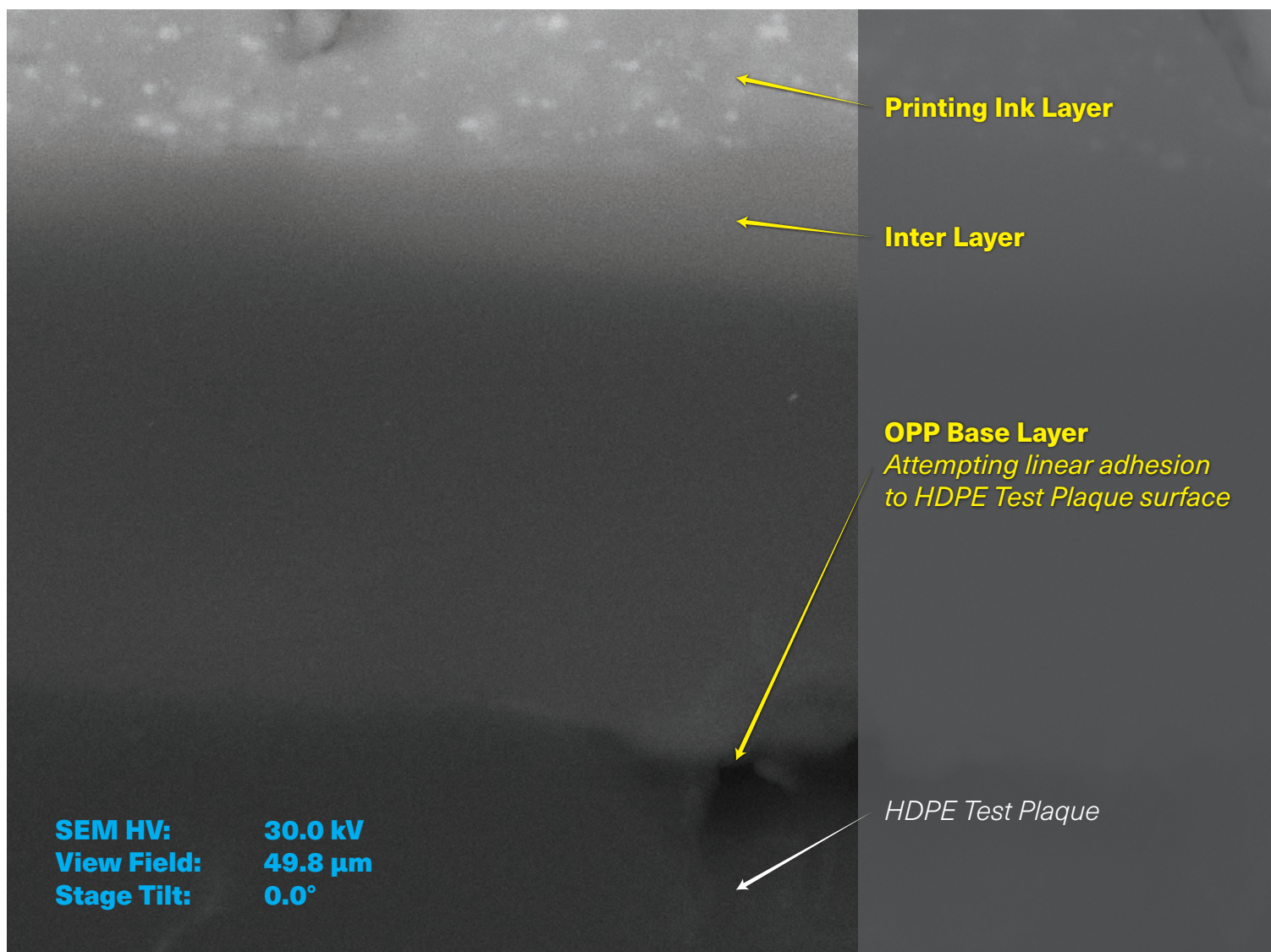


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Analysis 1 In Mold Label (IML) Construction

- 48.9 μm Magnification
(3 Construction layers observed)



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Analysis 2 Hot Stamp Foil

Applied to Injection Molded HDPE Test Plaque

- Construction Cross Section Imaging (20x and 50x)
- Construction SEM Magnification (10.0 μm)



Hot Stamp Foil Label Cross Section within Mounting Surface for SEM Analysis



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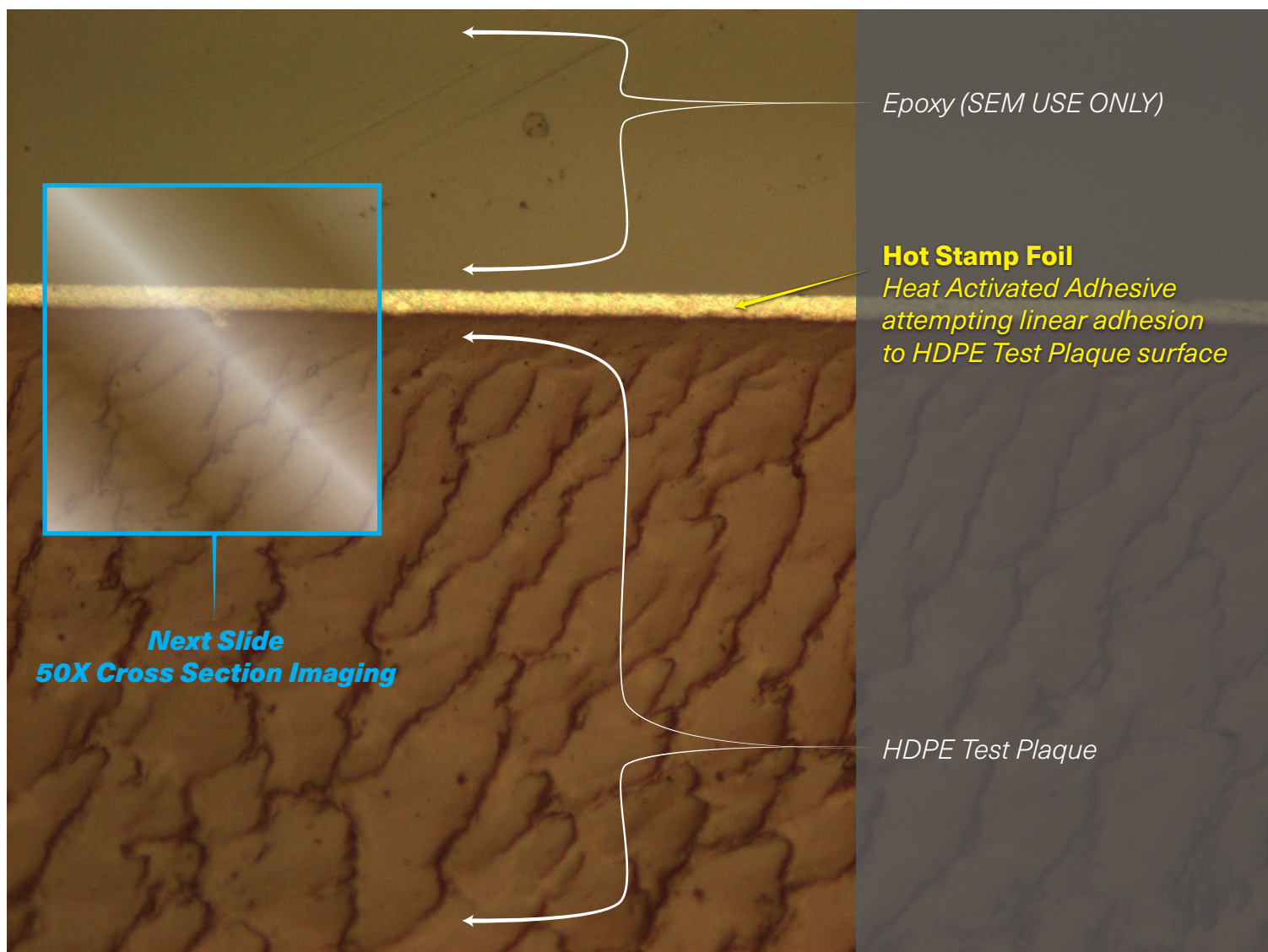
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Analysis 2 Hot Stamp Foil

- 20X Cross Section Imaging
(1 Construction layer observed)

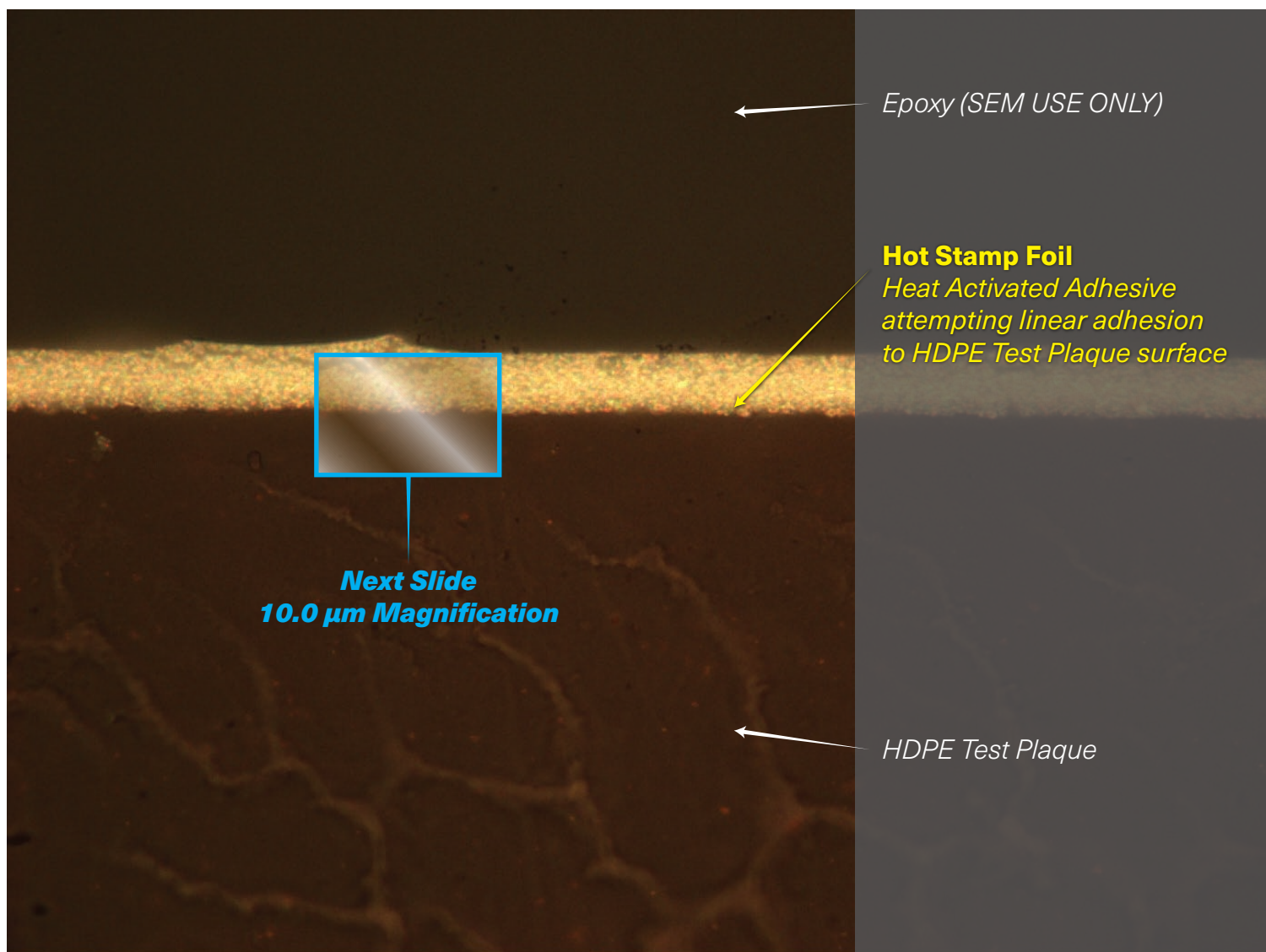


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Analysis 2 Hot Stamp Foil

- 50X Cross Section Imaging
(1 Construction layer observed)

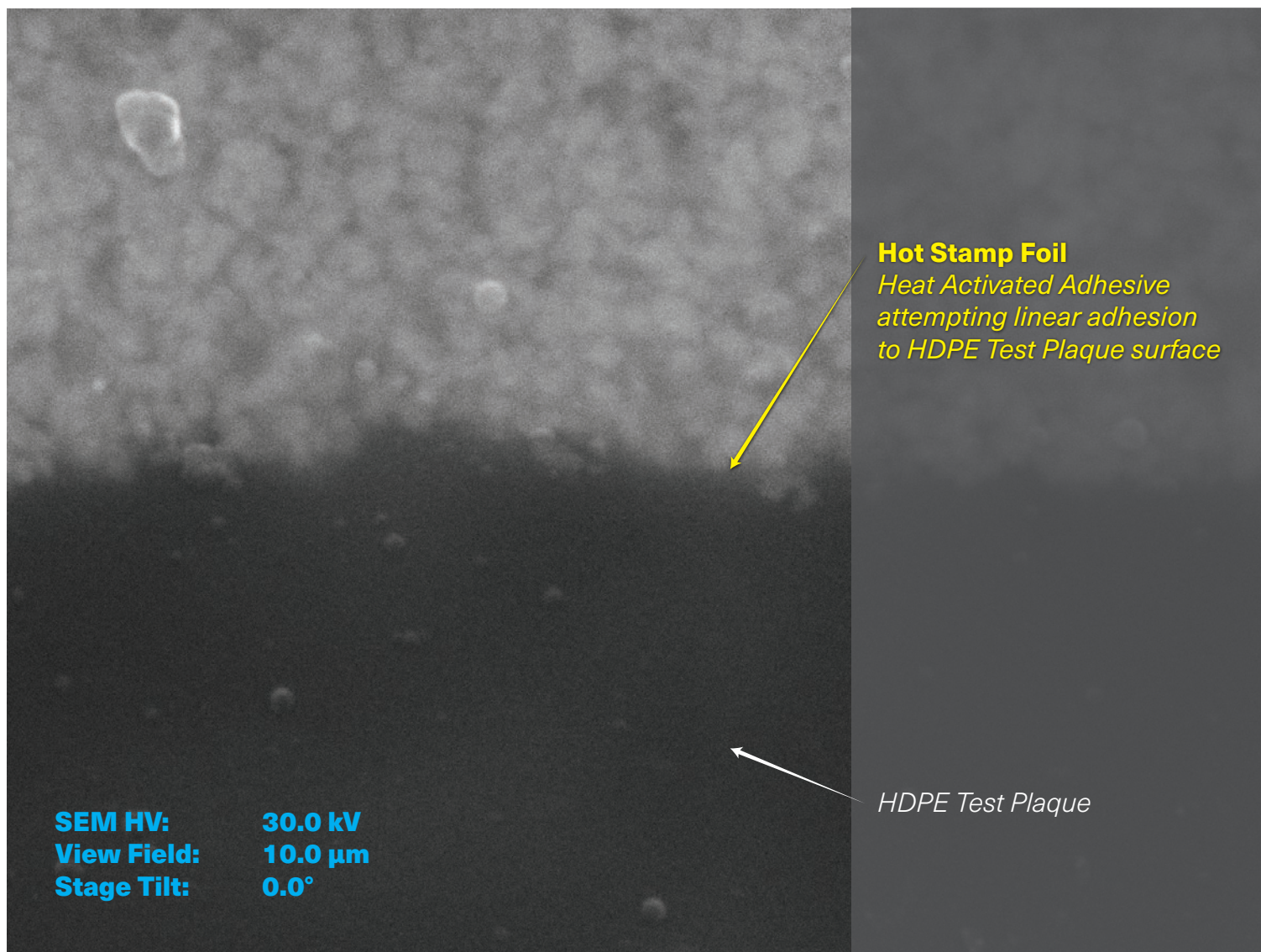


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Analysis 2 Hot Stamp Foil

- 10.0 μm Magnification
(1 Construction layer observed)



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Analysis 3 Pressure Sensitive Adhesive (PSA)

Applied to Injection Molded HDPE Test Plaque

- Construction Cross Section Imaging (5x and 10x)
- Construction SEM Magnification (10.0 µm)



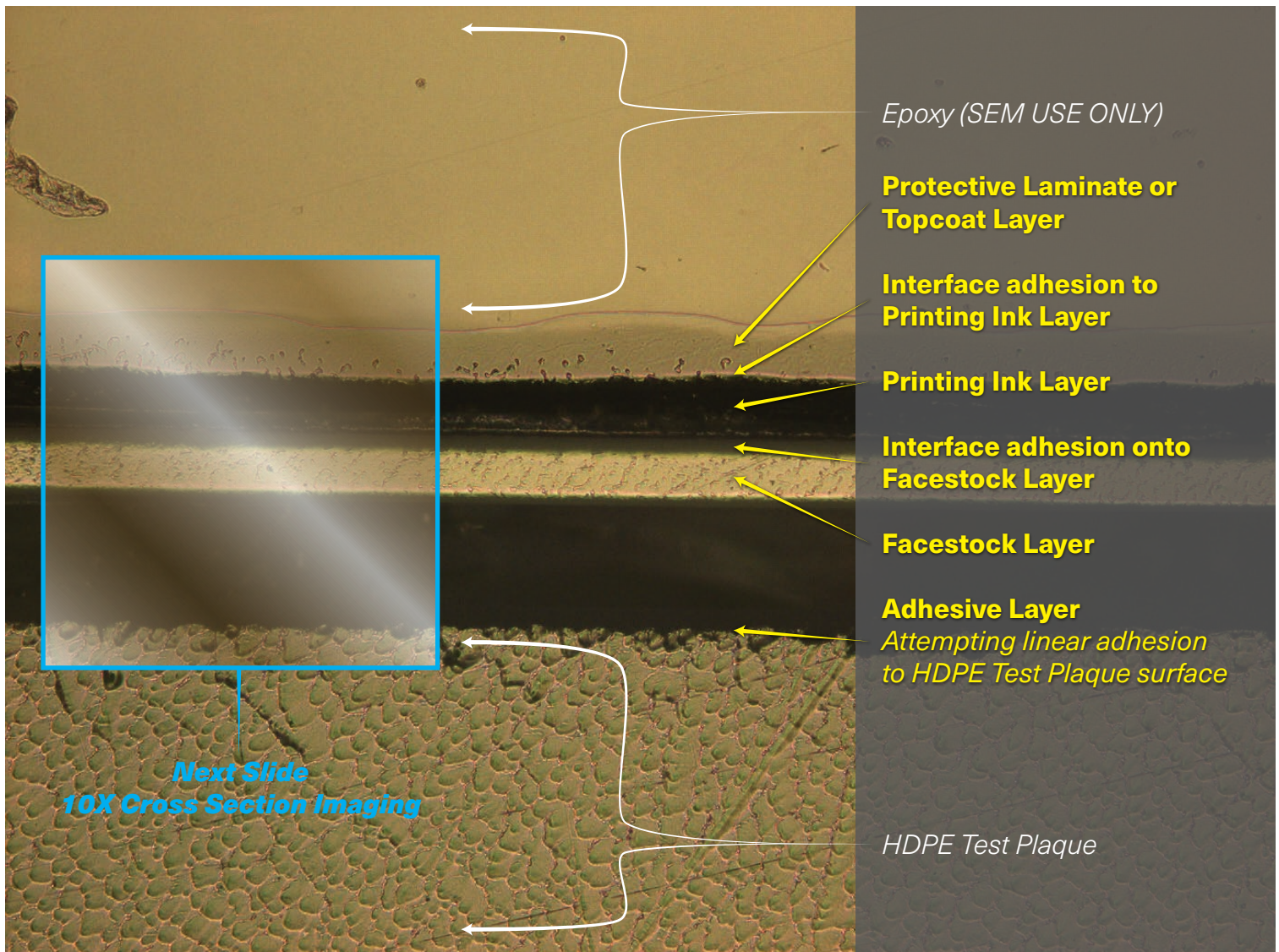
Pressure Sensitive Adhesive (PSA) Label Cross Section within Mounting Surface for SEM Analysis

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Analysis 3 Pressure Sensitive Adhesive (PSA)

- 5X Cross Section Imaging
(6 Construction layers observed)

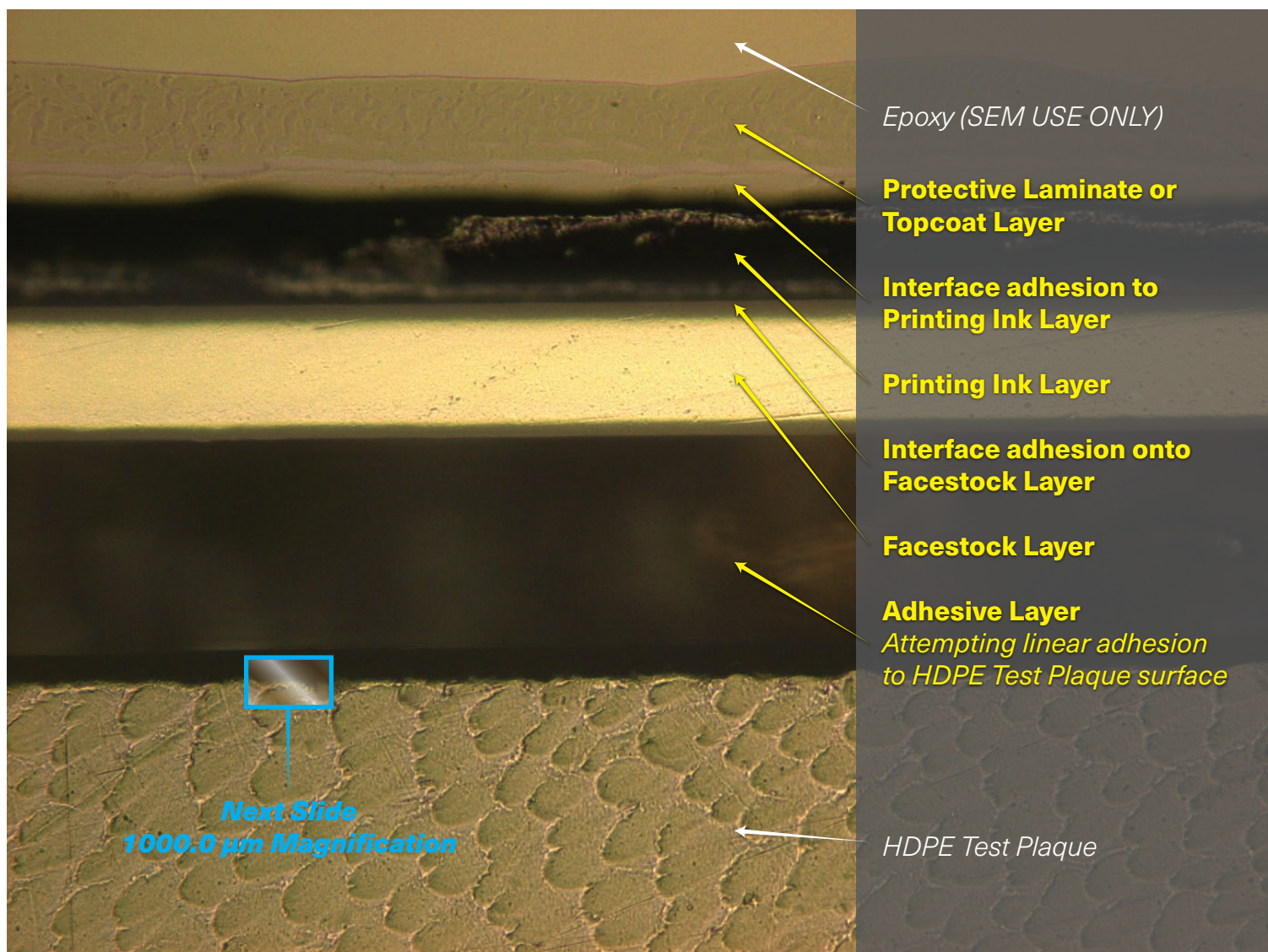


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Analysis 3 Pressure Sensitive Adhesive (PSA)

- 10X Cross Section Imaging
(6 Construction layers observed)

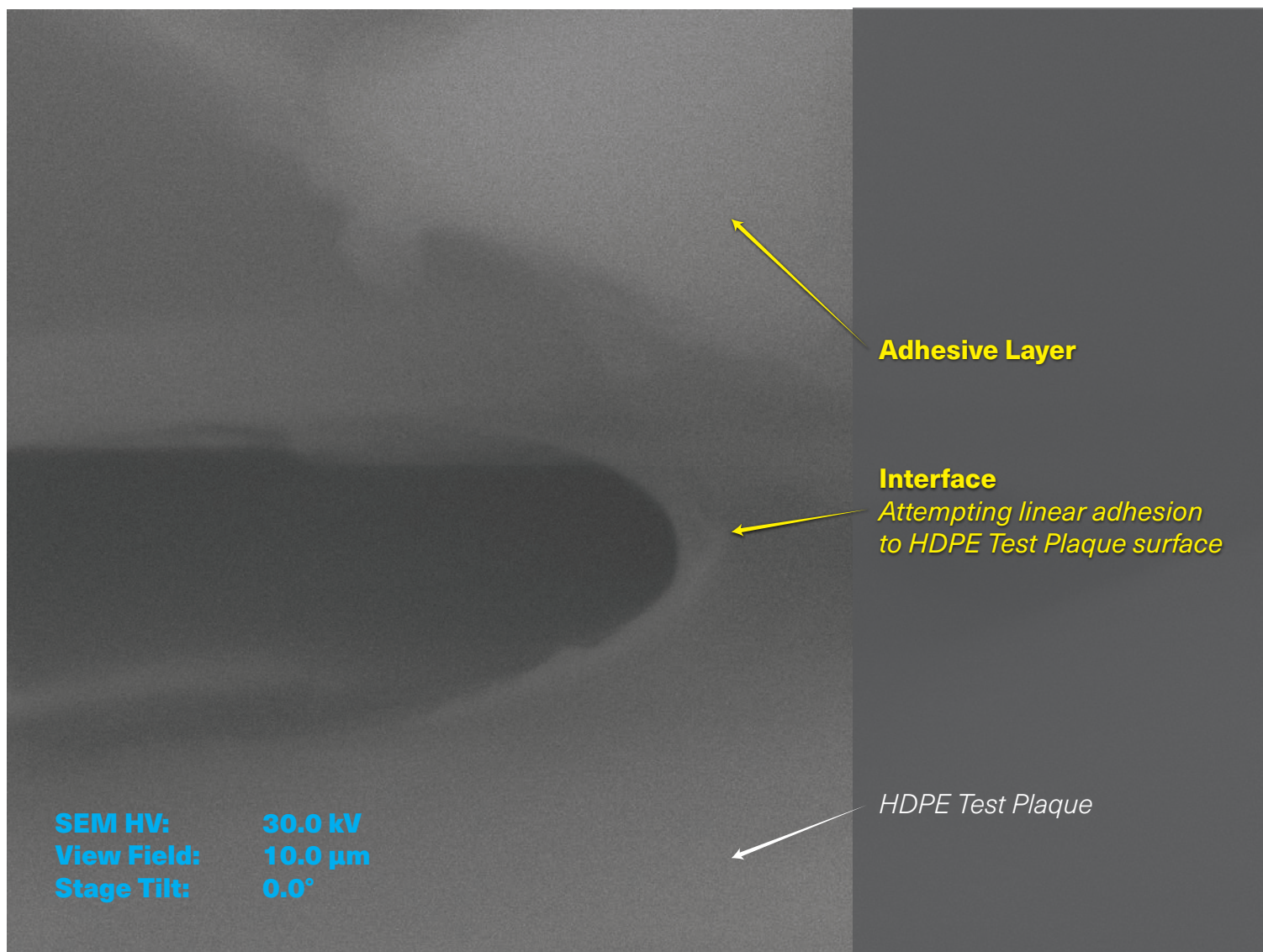


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Analysis 3 Pressure Sensitive Adhesive (PSA)

- 1000.0 μm Magnification
(6 Construction layers observed)

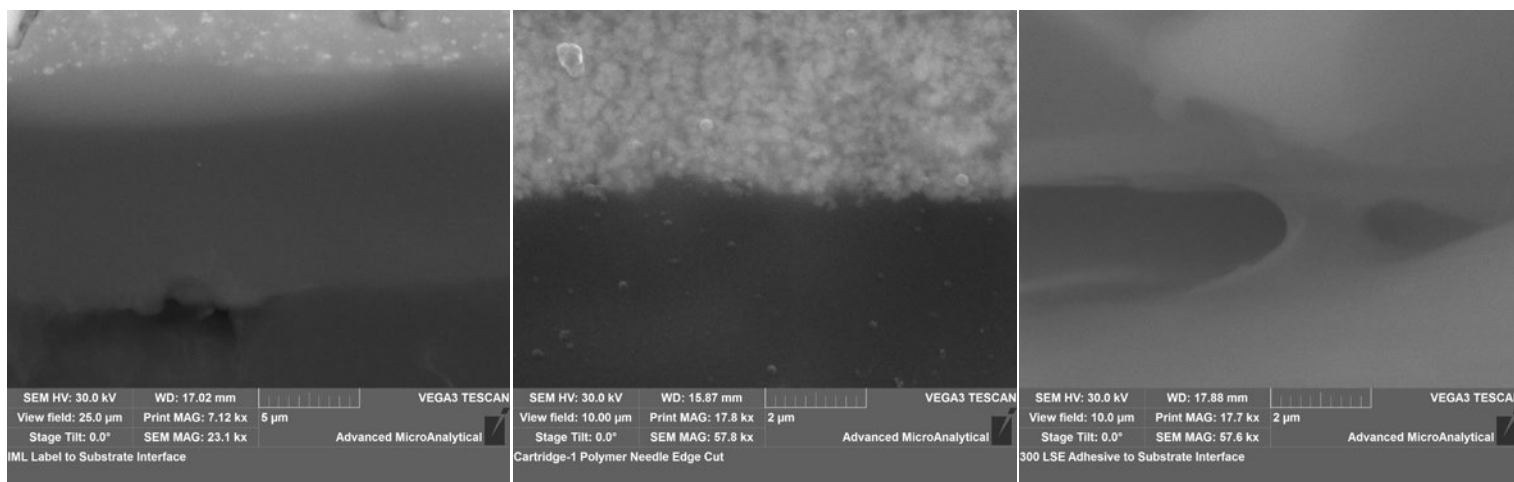


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Analysis 1-3 Summary

IML, Hot Stamp Foil, PSA



- Sample analysis for In Mold Label (IML), Hot Stamp Foil, and Pressure Sensitive Adhesive (PSA) shows only partial linear surface adhesion at interface to the low surface energy high density polyethylene (HDPE) test plaque surface.
- Label adhesion compromised by environmental or mechanical factors susceptible to potential long-term accelerated environmental & chemical degradation including failure.

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Analysis 4 Polymer Fusion Labeling

Applied to Injection Molded HDPE Test Plaque

- Construction Cross Section Imaging (20x and 50x)
- Construction SEM Magnification (100.0 μm , 20.0 μm)



Polymer Fusion Label Cross Section within Mounting Surface for SEM Analysis



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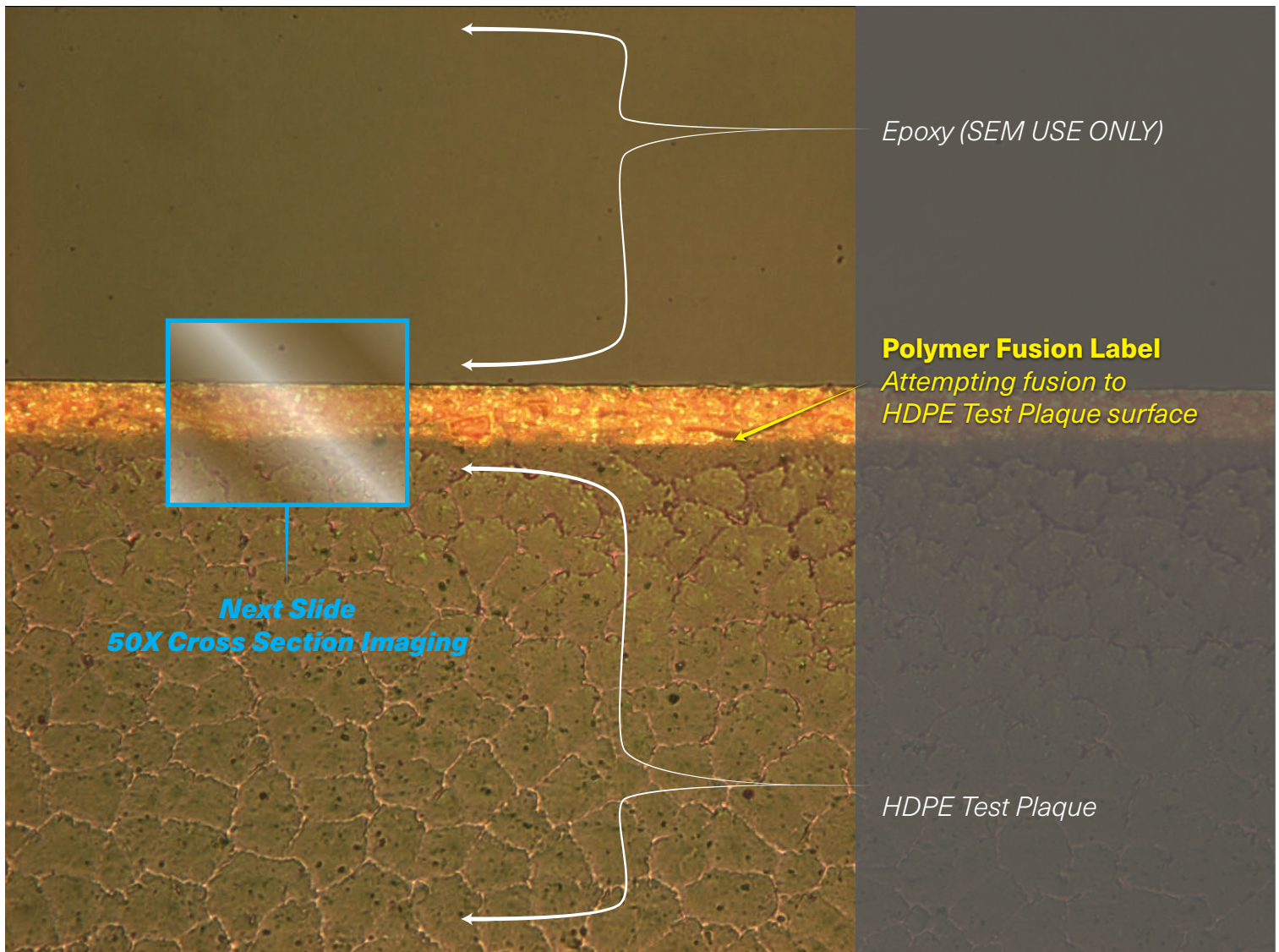
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Analysis 4 Polymer Fusion Labeling

- 20X Cross Section Imaging
(1 Construction layer observed)

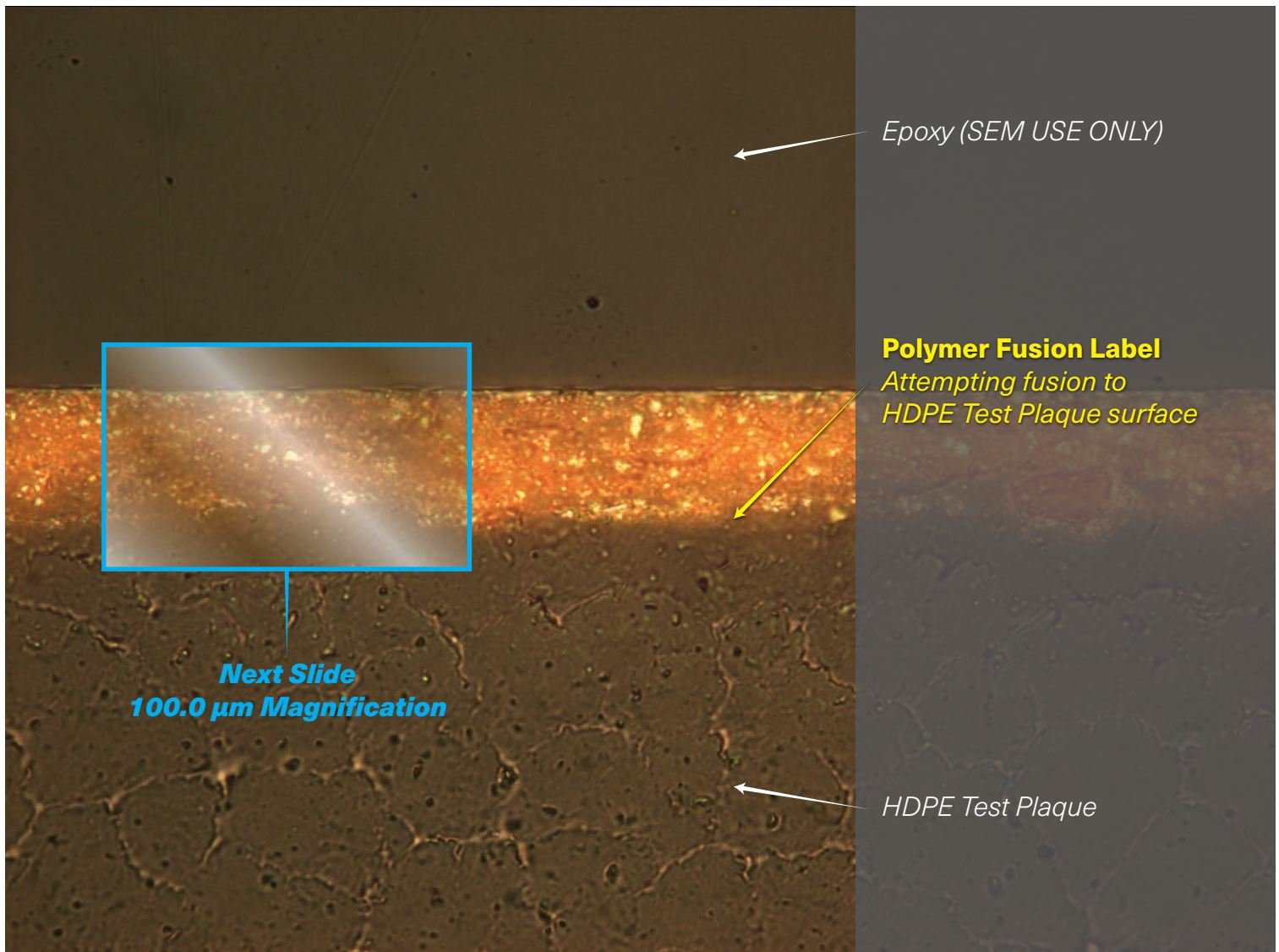


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Analysis 4 Polymer Fusion Labeling

- 50X Cross Section Imaging
(1 Construction layer observed)

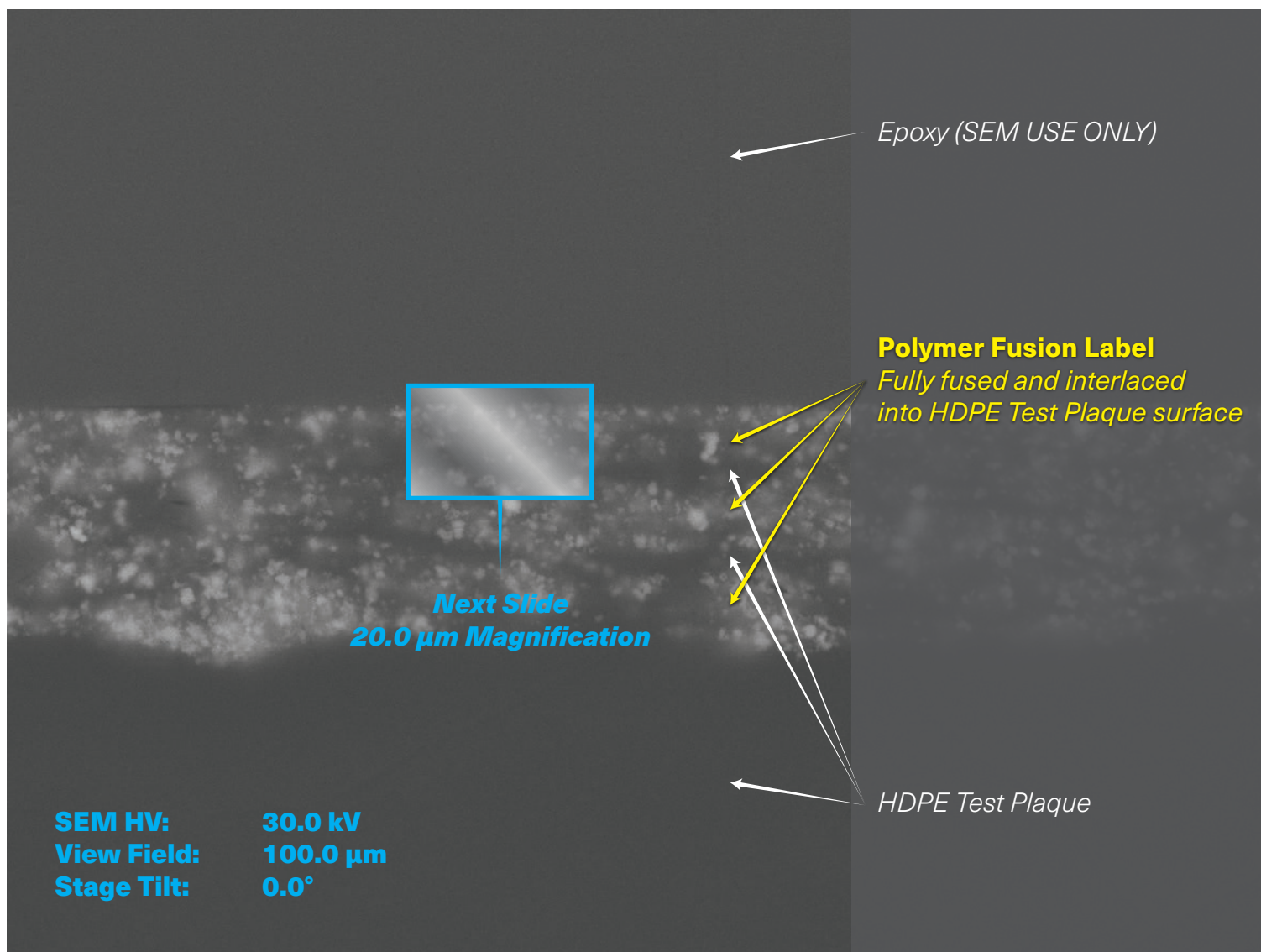


Scanning Electron Microscopy (SEM) Analysis

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Analysis 4 Polymer Fusion Labeling

- 100.0 μm Magnification
(1 Construction layer observed)

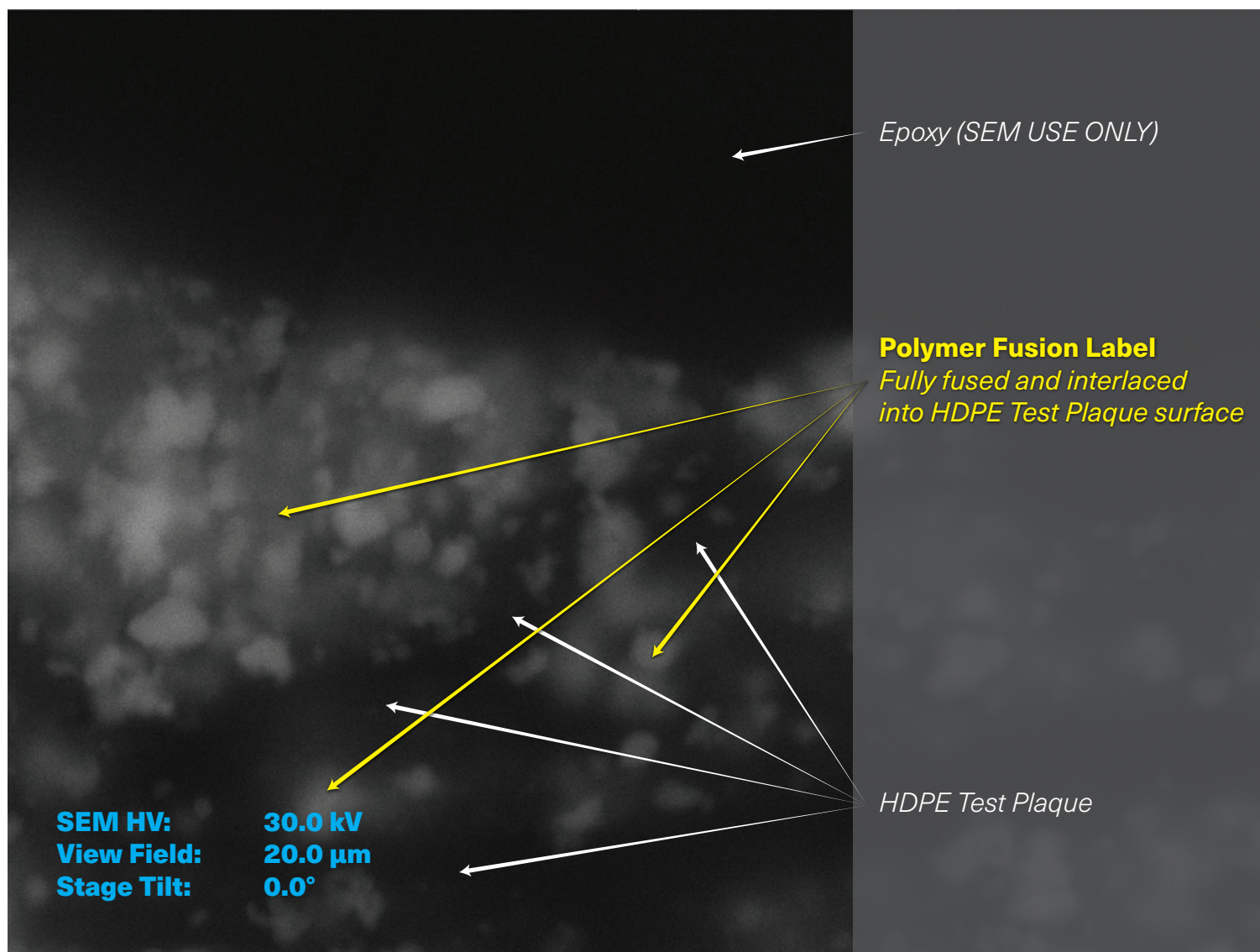


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Analysis 4 Polymer Fusion Labeling

- 100.0 μm Magnification
(1 Construction layer observed)

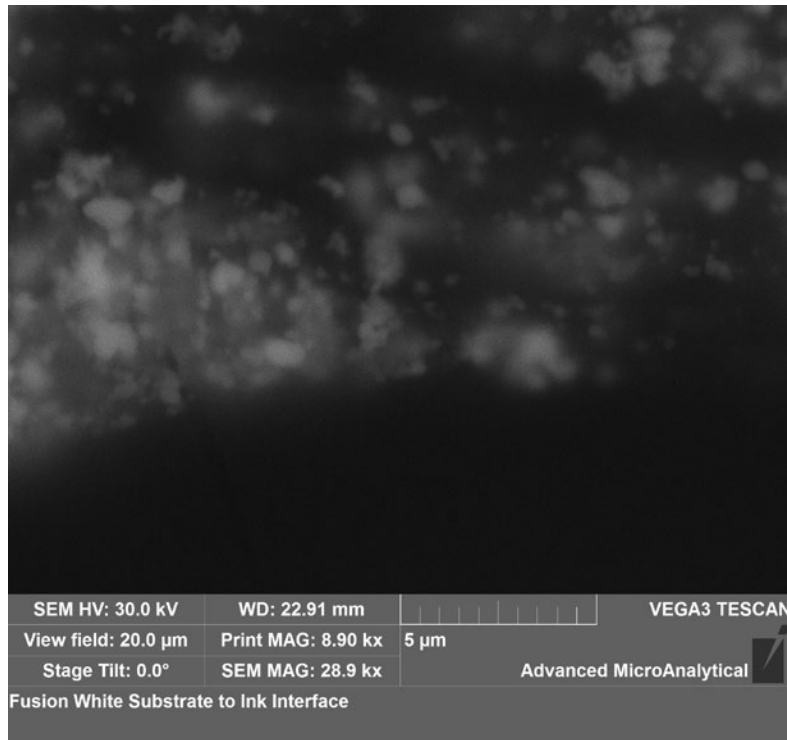


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Analysis 4 Summary

Polymer Fusion Labeling



- Fully Fused and intertwined into HDPE test plaque (*No Linear Adhesion*).
- Fully compatible, adopting all polyolefin thermoplastic characteristics (Durability, Longevity, Impervious to Environmental & Chemical Degradation, Recycleability).
- Compatible and permanent label integration into hard-to-label polyolefin thermoplastic products, parts, and components.
- Guaranteed for life.



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SEM Analysis Conclusion

IML, Hot Stamp Foil, PSA

When applied onto low surface energy polyolefin thermoplastic products and components, long-term durability and permanence of surface bonded labeling methods (IML, Hot Stamp, PSA, and others) is questionable and solely dependent on the effectiveness of adhesion to the substrate.

As confirmed in this analysis, data shows that linear surface adhesion samples were ineffective in forming a truly permanent bond with the base HDPE Test Plaques, a problem that is further accelerated when protective outer layers are compromised exposing adhesion sites to environmental & chemical attack.

Polymer Fusion Labeling

Only Polymer Fusion Technology proved to integrate fully and completely at the molecular level, taking on the same durable characteristics of the HDPE Test Plaque.



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