

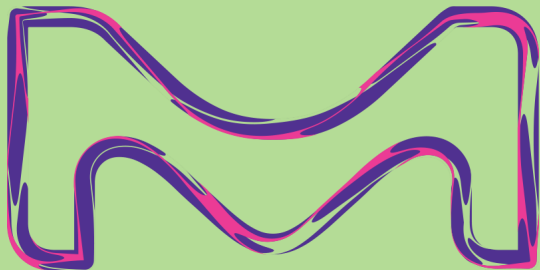
The performance materials business of Merck KGaA, Darmstadt, Germany operates as EMD Performance Materials in the U.S. and Canada.

Advanced photoresists for the MORE-THAN-MOORE industry

Performance Materials, Semiconductor Solutions

Dr. Fumio Kita

MEMS & Imaging Sensors
Grenoble, 25th-27th of September 2019

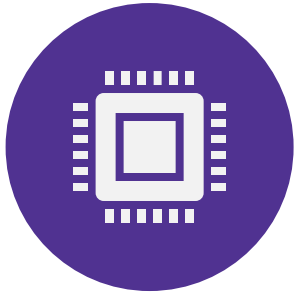


**EMD
PERFORMANCE
MATERIALS**

The Semiconductor Industry

Market Segments Based on Device Types

Logic



**Memory
(DRAM & NAND)**



**MtM
(More than Moore)**



Hard Disks



Packaging

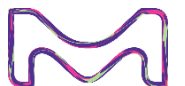


MEMS Devices

Power Devices

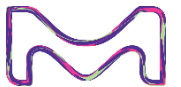
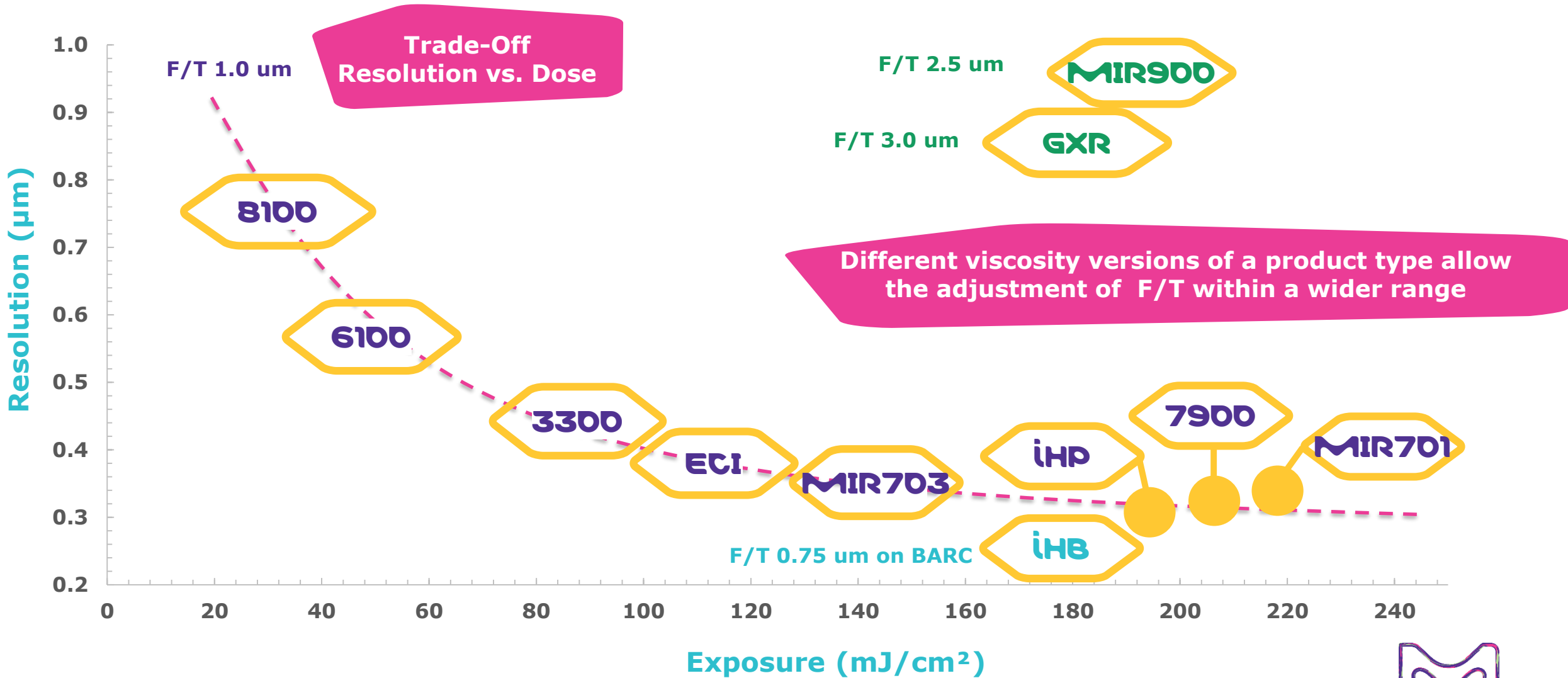
**Optoelectronic Devices
(Image Sensor, Laser, LED)**

RF Devices



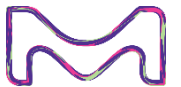
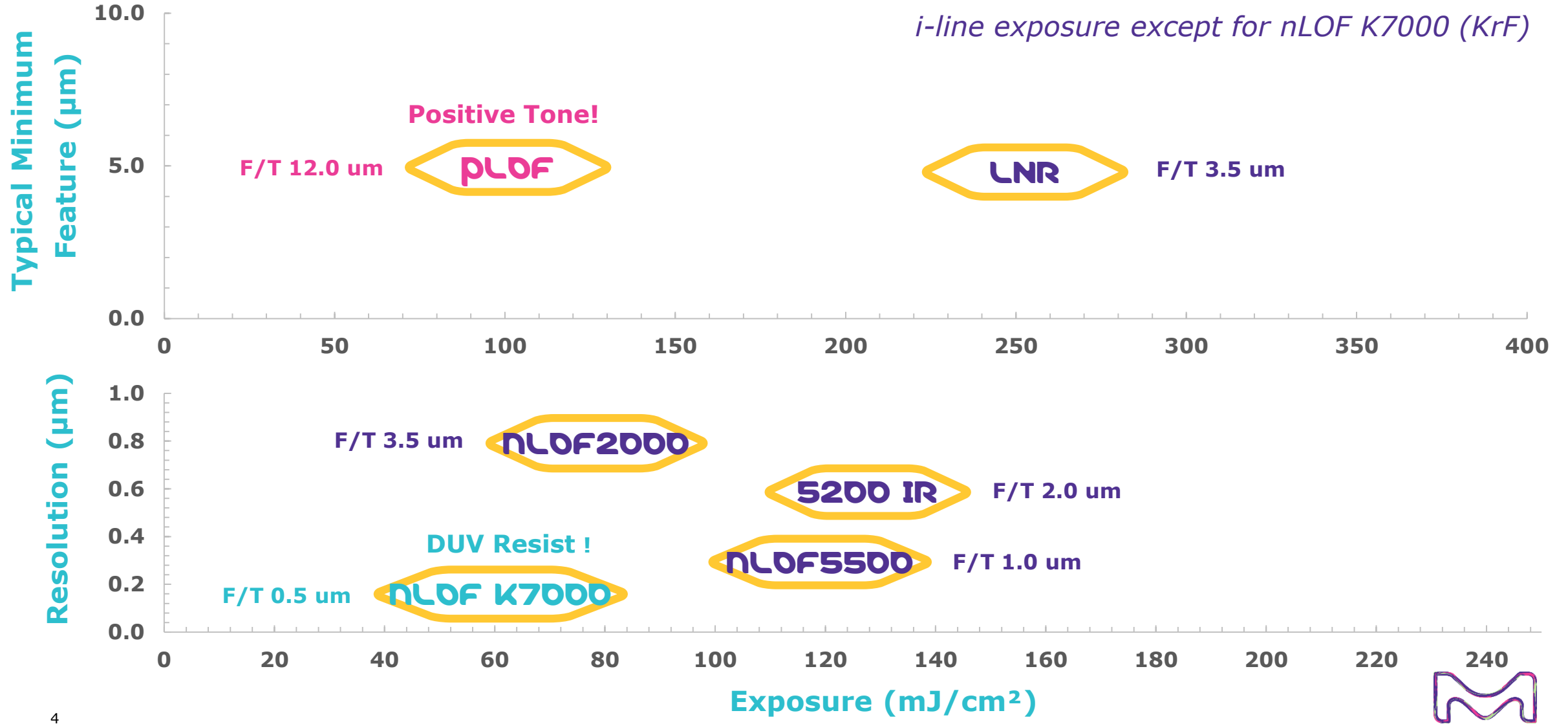
Product Line-up

EMD's i-line Resist Portfolio (Positive Tone)



Product Line-up

EMD's Lift-Off Resists Portfolio (Negative Tone)



Product Line-up

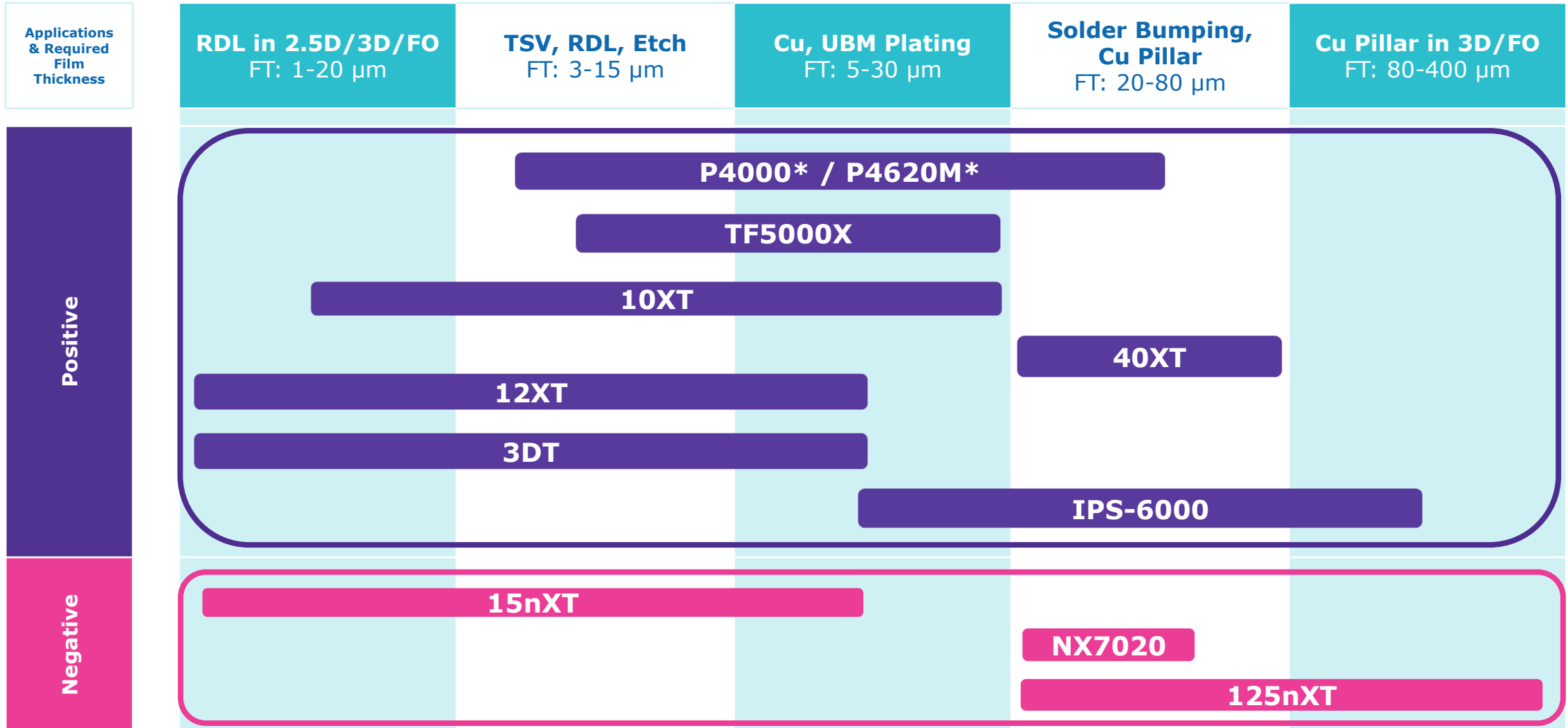
EMD's Photoresist and Generic Semiconductor Processes

Process & Required Film Thickness	Etching (Dry, Wet) Implant FT: 0.5-4 μm	Lift-Off FT: 0.5-15 μm	Dry Etch, Implant FT: 4-15 μm	RIE in MEMS FT: > 20 μm
Positive	<ul style="list-style-type: none"> iHB* iHP* 7900* MIR 700* ECI 3300 6100 8100 MIR 900* GXR 	<ul style="list-style-type: none"> pLOF* 	<ul style="list-style-type: none"> P4000** / P4620M** TF5000X 10XT 12XT 3DT 	<ul style="list-style-type: none"> 40XT IPS-6000
Negative		<ul style="list-style-type: none"> nLOF5500 nLOF2000 LNR* nLOF K*** 	<ul style="list-style-type: none"> 15nXT 	<ul style="list-style-type: none"> NX7020 125nXT
Image Reversal	<ul style="list-style-type: none"> 5200 			

Note: i- and g-line sensitivity except: *pure i-line **pure g-line ***KrF-line

Product Line-up

EMD's Thick-Film Resists Portfolio for Packaging

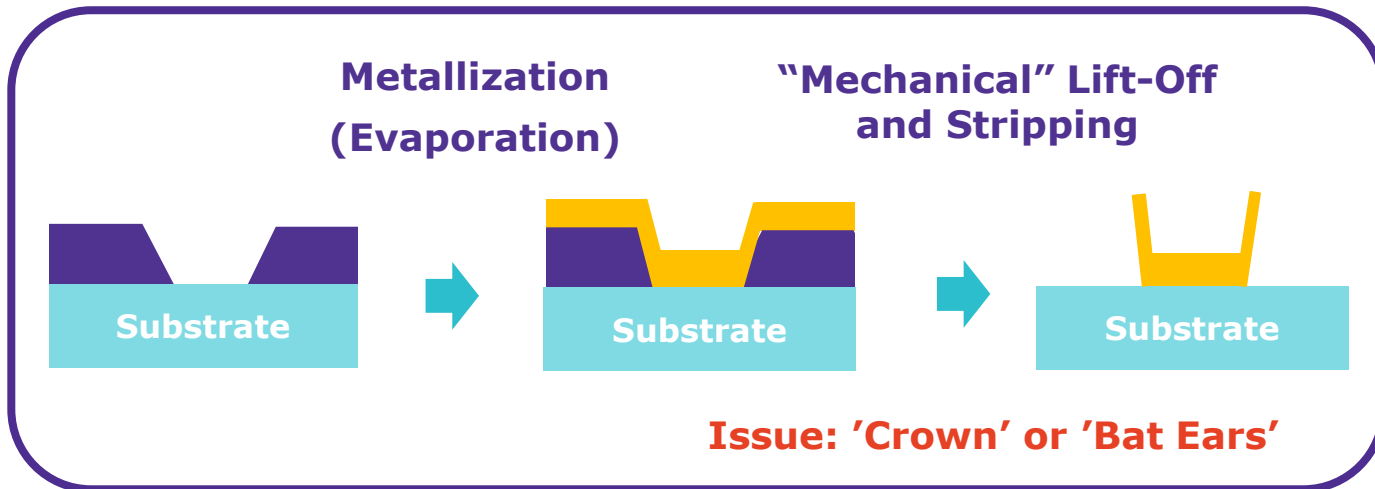


Note: i- and g-line sensitivity except: *pure g-line

Recent Developments: AZ pLOF Photoresist

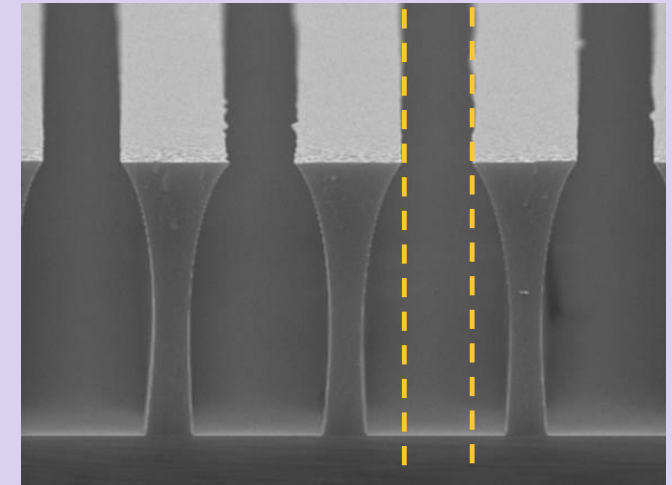
Positive-Tone Photoresist in a Lift-Off Process for Metallization

Miniaturization in backend processes & increasing demand in precision limit utilization of **'mechanical'** lifting



- **Positive-tone i-line** photoresist with **'negative'** profile
- Profile ideal for **lift-off** process
- **Excellent removal** in lift-off process
- Film thickness range: 5 – 15 μm

- **Tapered Profile**

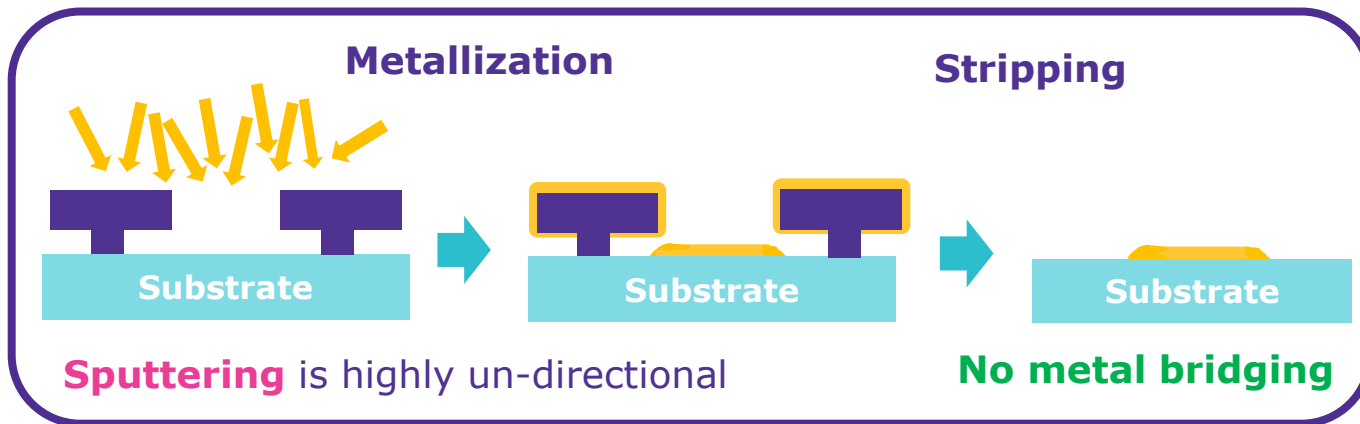


Dimensions of the profile:

- Line opening (top): 3 μm
- Film thickness: 12 μm

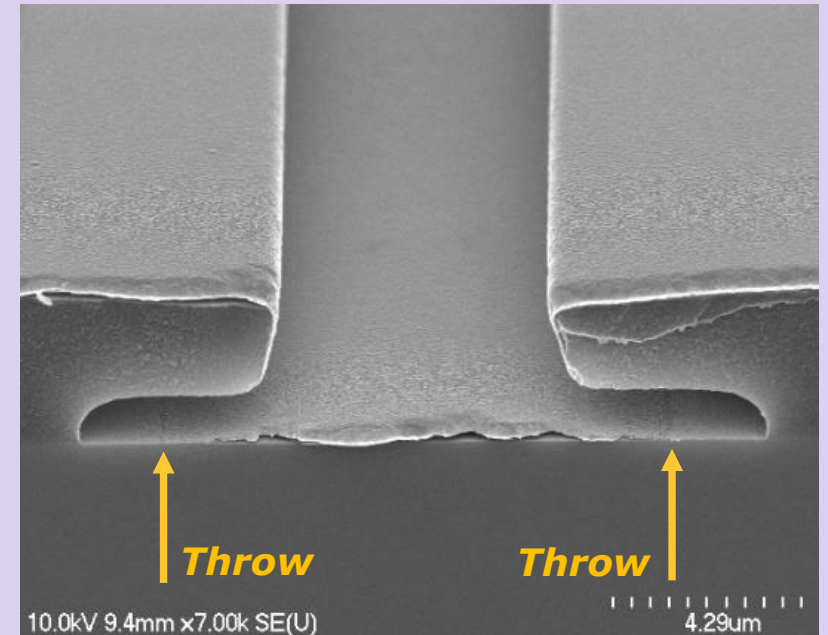
Recent Developments: AZ LNR Photoresist Optimized for Sputtering in a Lift-Off Process for Metallization

Why is a photoresist with **high undercut** necessary?



- **Negative-tone i-line** photoresist
- **Single coating** solution with high undercut
- Ideal to combine **sputtering** with **lift-off**
- Profile is reliably **reproducible**
- Profile is **adjustable** by process parameters
- Good **removal** properties

- Uniform **Throw-Distance** of sputtered metal



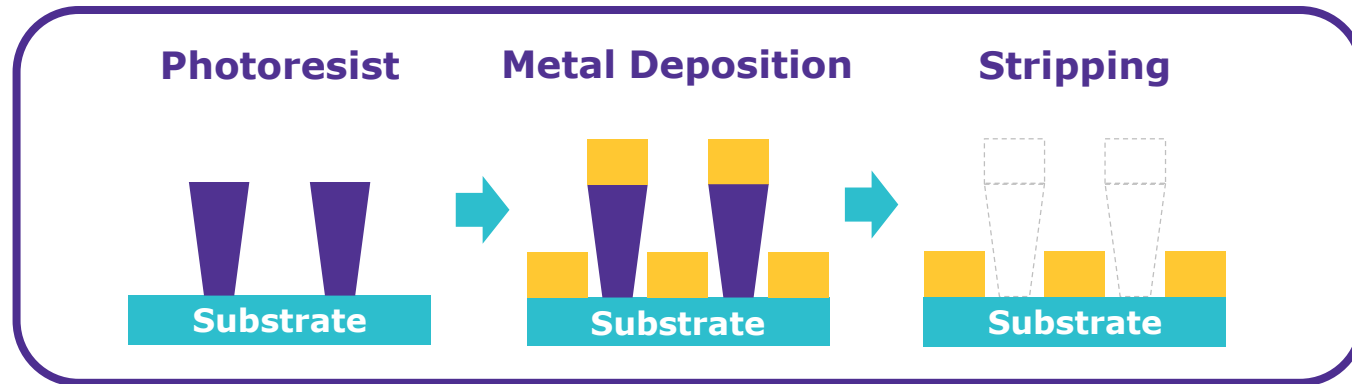
Dimensions of the profile:

- Undercut height: 1.1 um
- Undercut distance: 3.6 um
- Film thickness: 3.5 um

Recent Developments: AZ nLOF K7000 Photoresist KrF Photoresist in a Lift-Off Process for Metallization

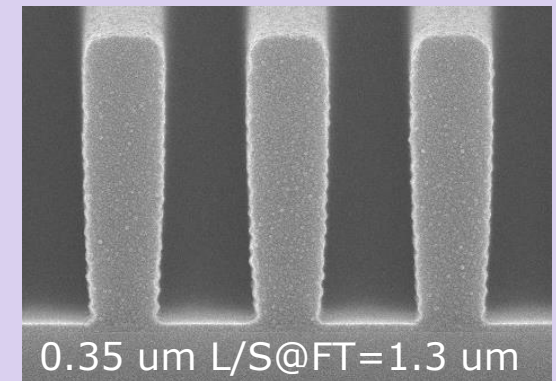
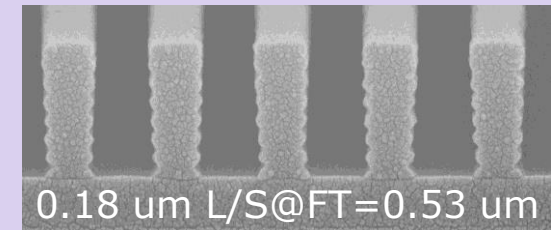
5G standard is pushing the **RF Filter** evolution

- further miniaturization
- higher **absolute CD precision** requirements
- limits for i-line based systems



- **Negative-tone KrF** photoresist
- Tapered profile ideal for **lift-off** process
- Film thickness range: 0.5 – 1.5 μm

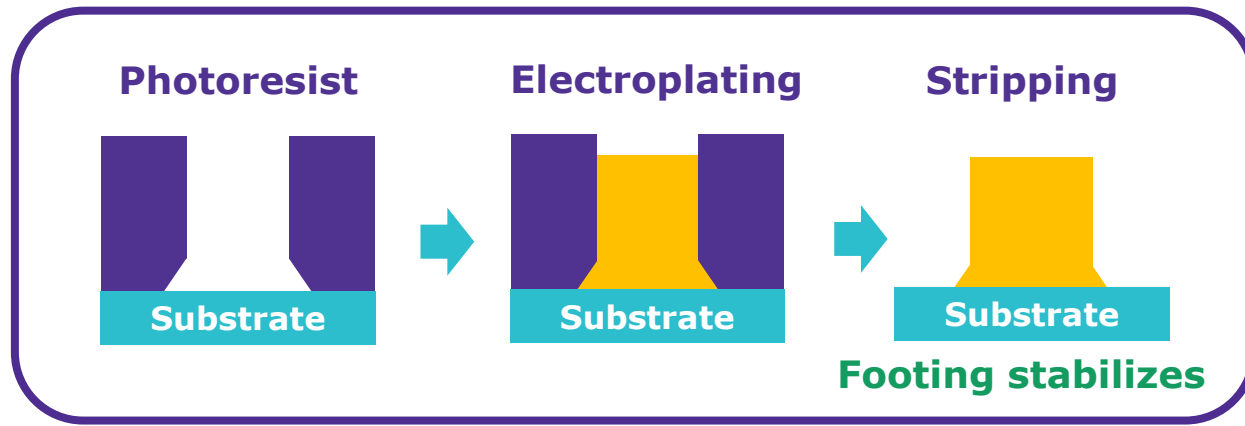
- **High Precision**
(far beyond i-line system)



Recent Developments: AZ 3DT-400

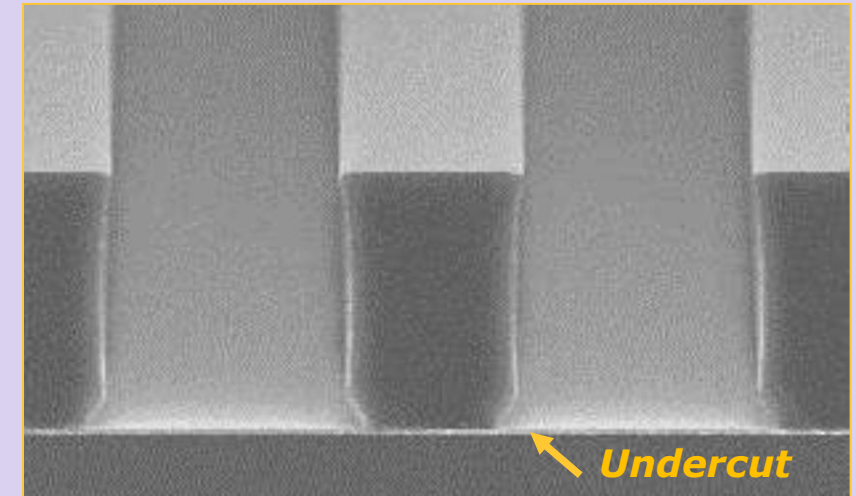
Positive-tone Photoresist for Electroplating Applications

- The photoresist profile is the template for the electroplated metal
- A **designed undercut** is beneficial



- **Positive-tone i-line and bb** photoresist
- Unique feature: designed with **slight undercut**
- Profile ideal for **electroplating**
- Excellent **removal** properties
- Photoresist film thickness range: 5 – 20 μm
- High aspect ratio of (5 : 1)

- **Designed *Undercut*** creates small footing that **stabilizes electroplated structure**



Dimensions of the profile:

- Film thickness: 12 μm

EMD Performance Materials Market Approach

Dedicated to Semiconductor Industry

Global Footprint

Technical Service Support

Address special needs and provide customer specific solutions (R&D)

Partnership approach and open to Joint Development Activities

