CONSULTING LTD

Managing flexible webs for vacuum roll-to-roll deposition for electronic or ultra-barrier applications

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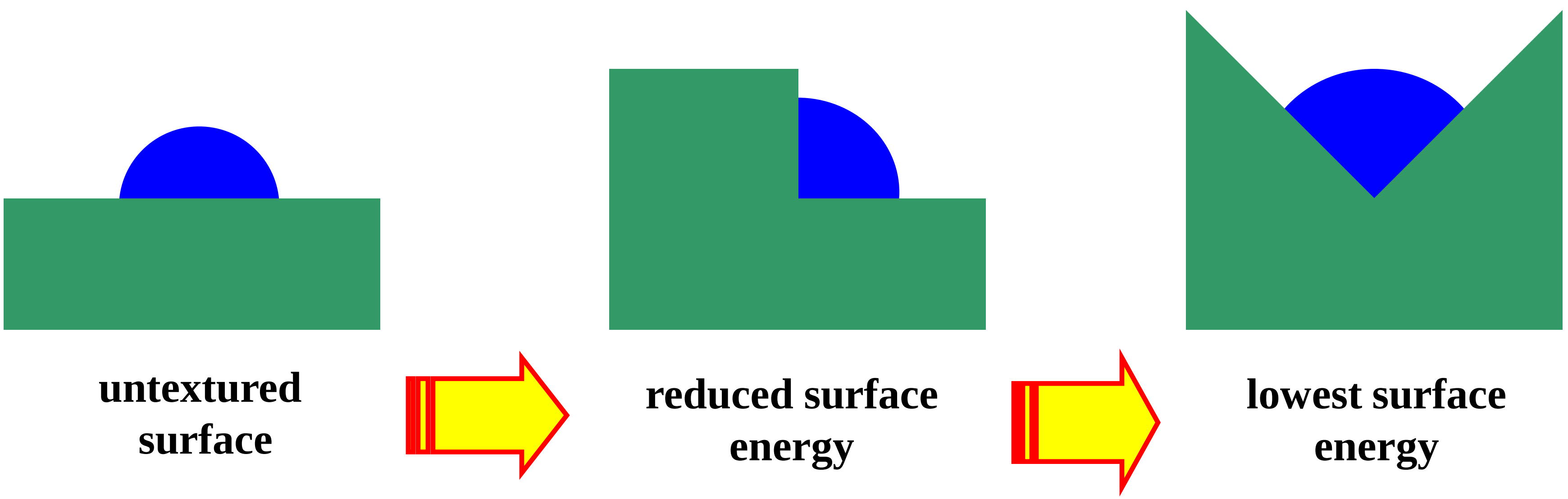
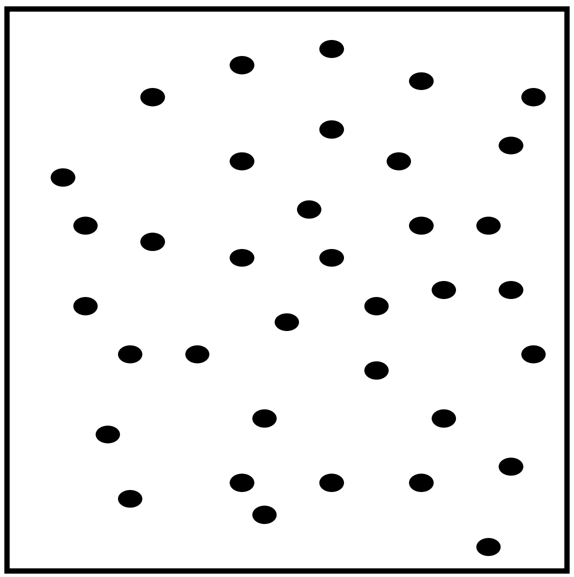
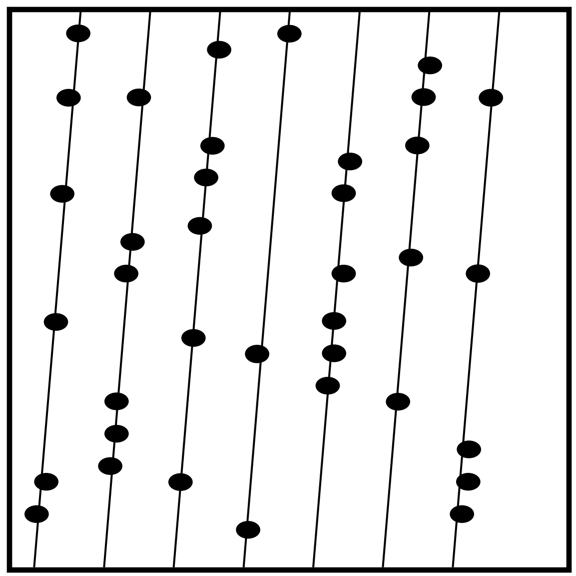
Nucleation
minimising surface energy



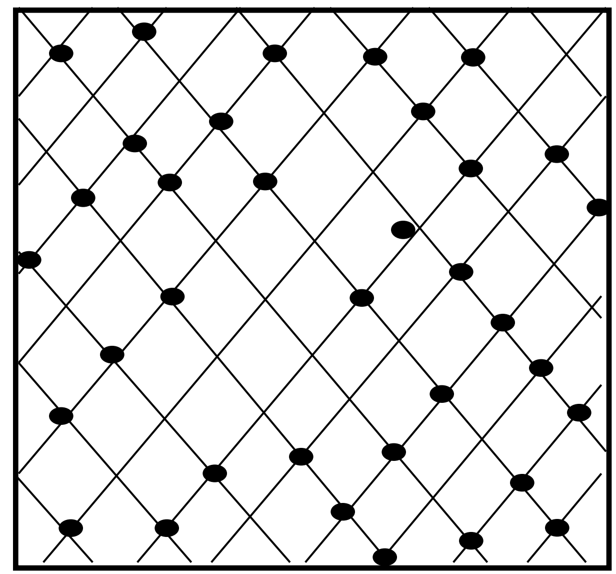
Influence of texture on nucleation



no texture - random nucleation



simple grooves preferred nucleation in grooves



crossed grooves preferred nucleation in pyramid pits

Texture

Random

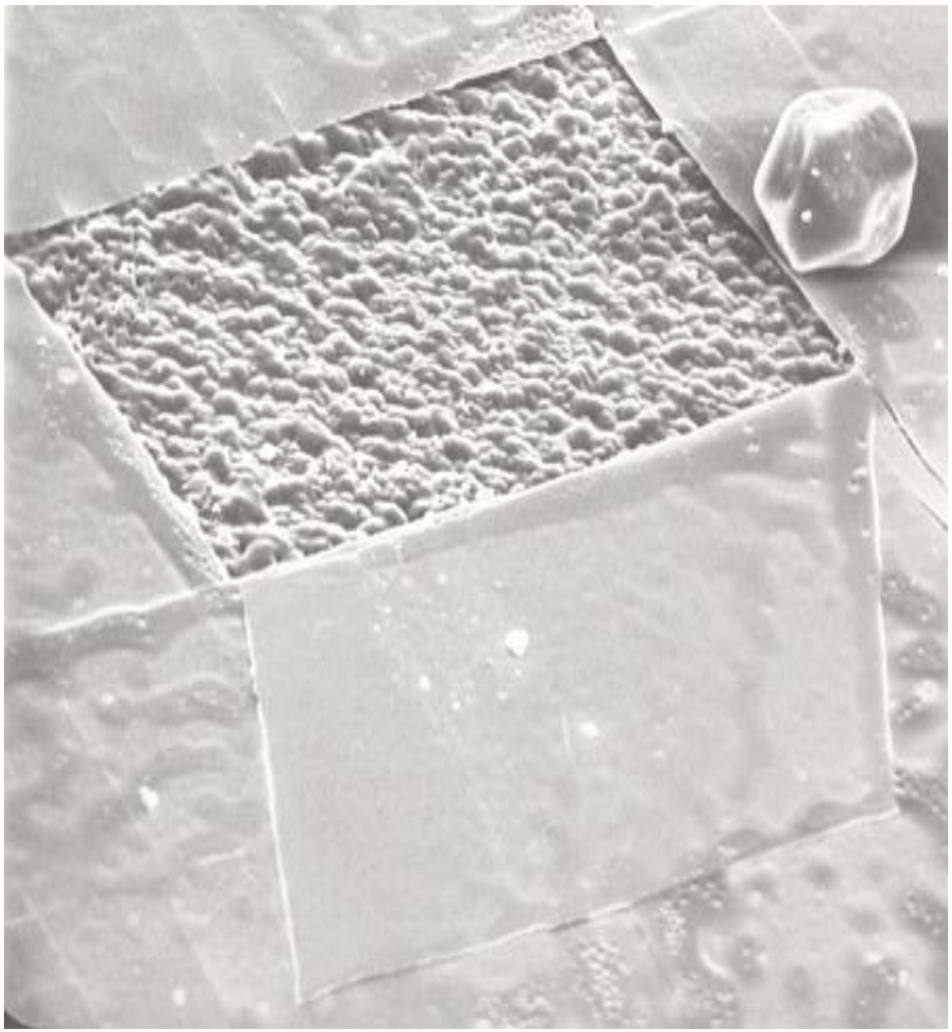
– Chemical etching
– Laser ablation/etching
– Plasma etching
– Hairy surface

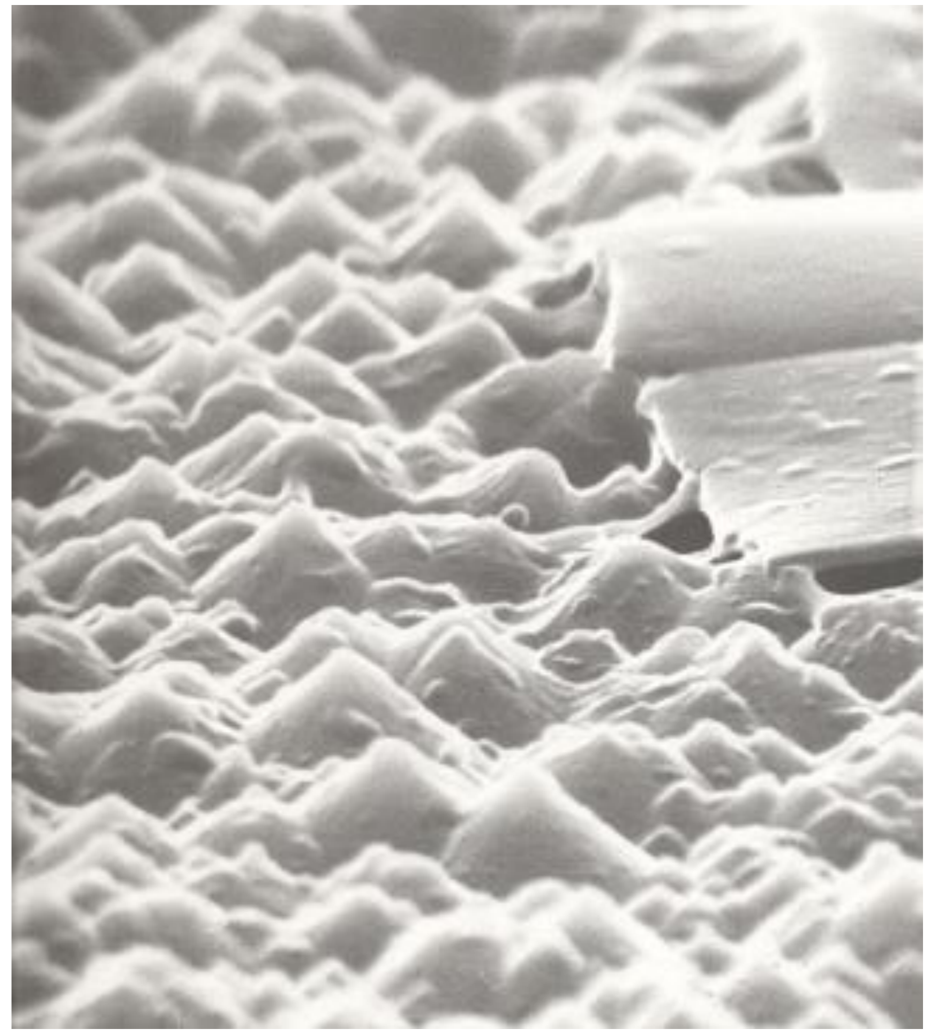
similar

Regular

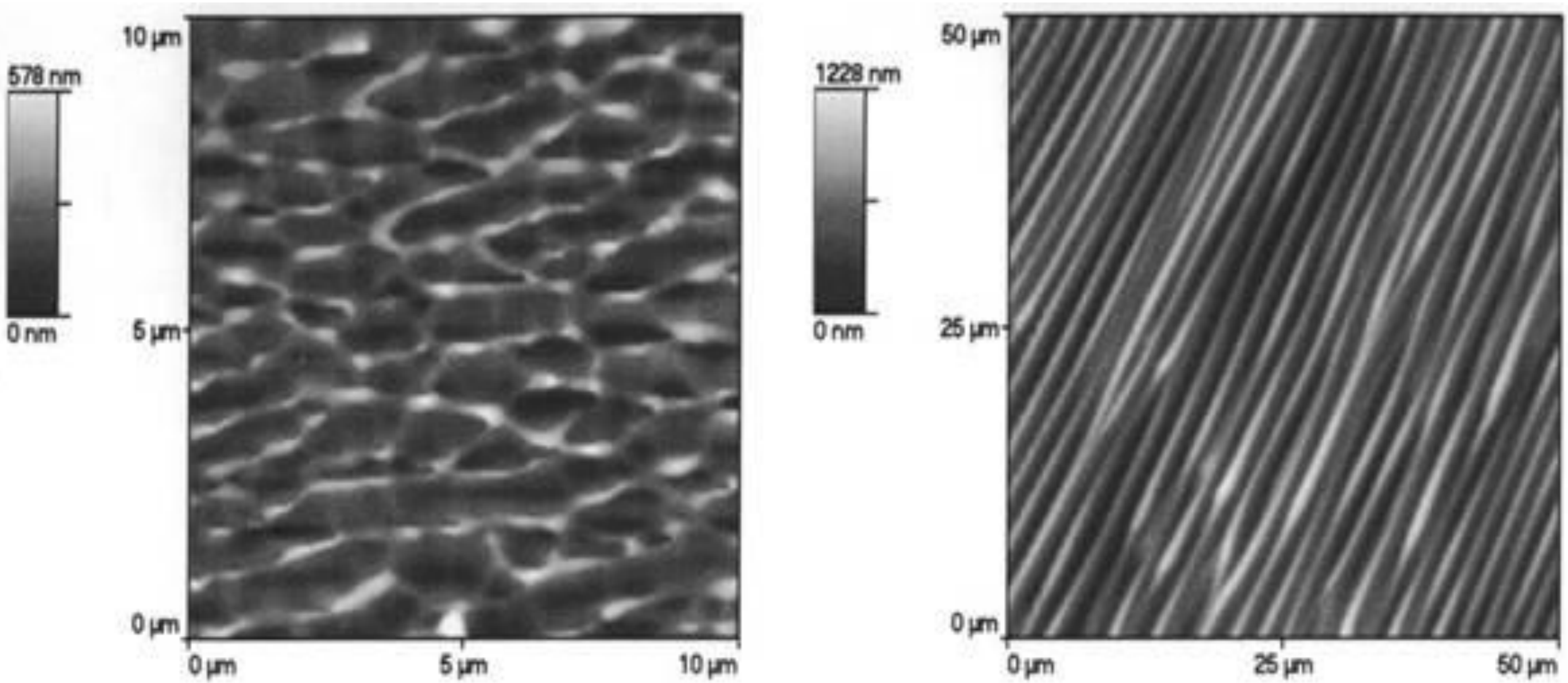
– Laser writing
– Printing
– Embossing

Orthochlorophenol etched polyester



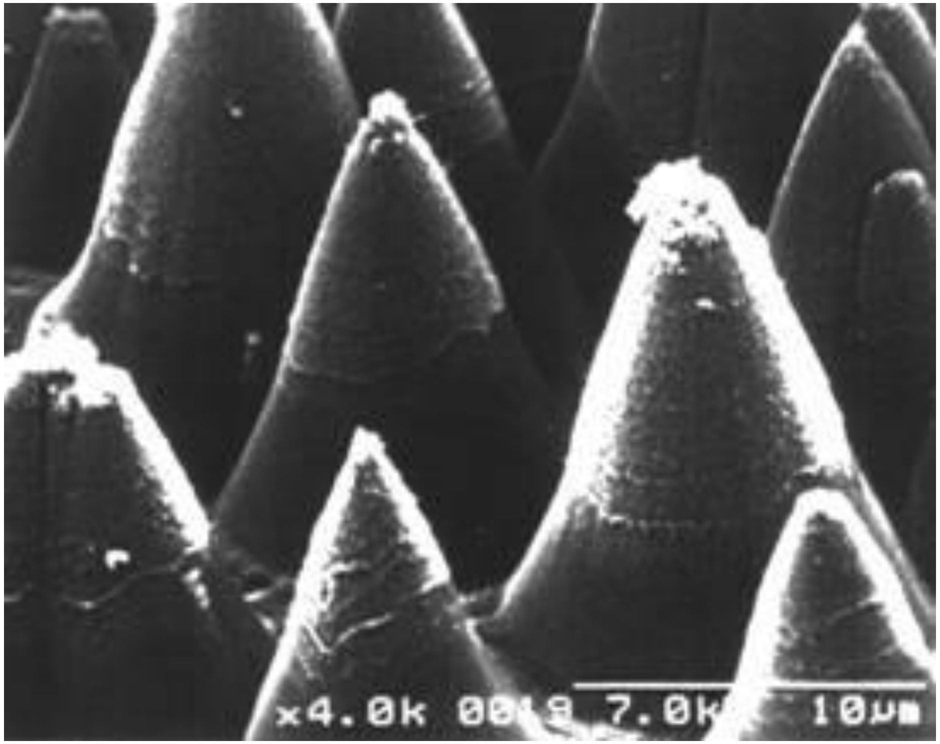


Laser ablation/etching

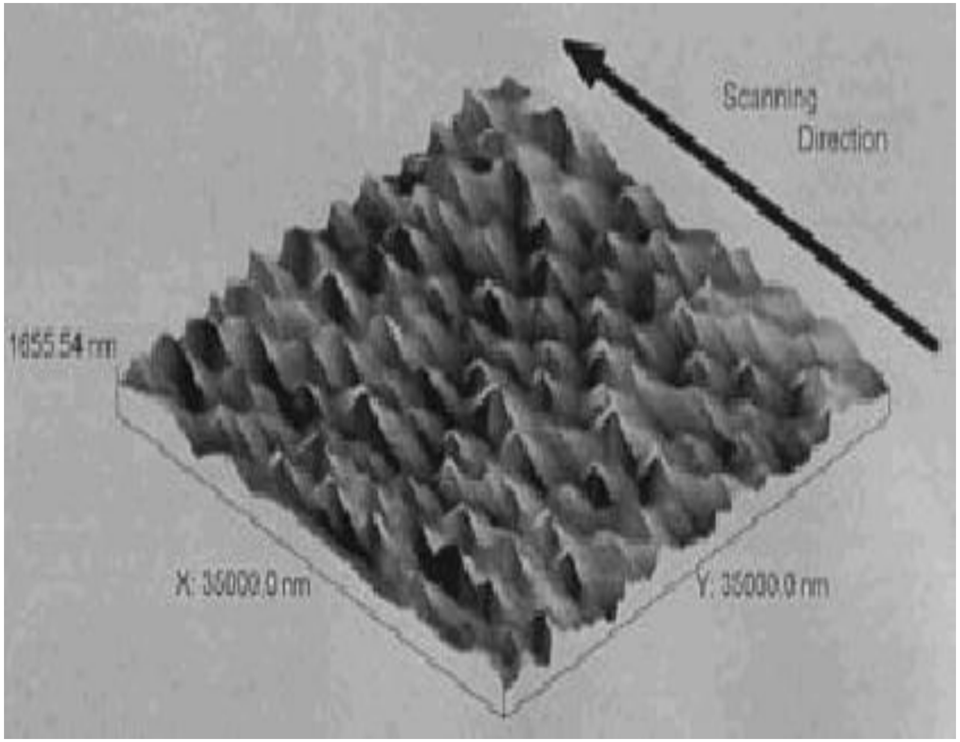


Atomic force microscope picture of the surface structure developed on the ablated PET film at 0 and 85 degrees. Dyer et al. Hull Univ.

Laser ablation/etching

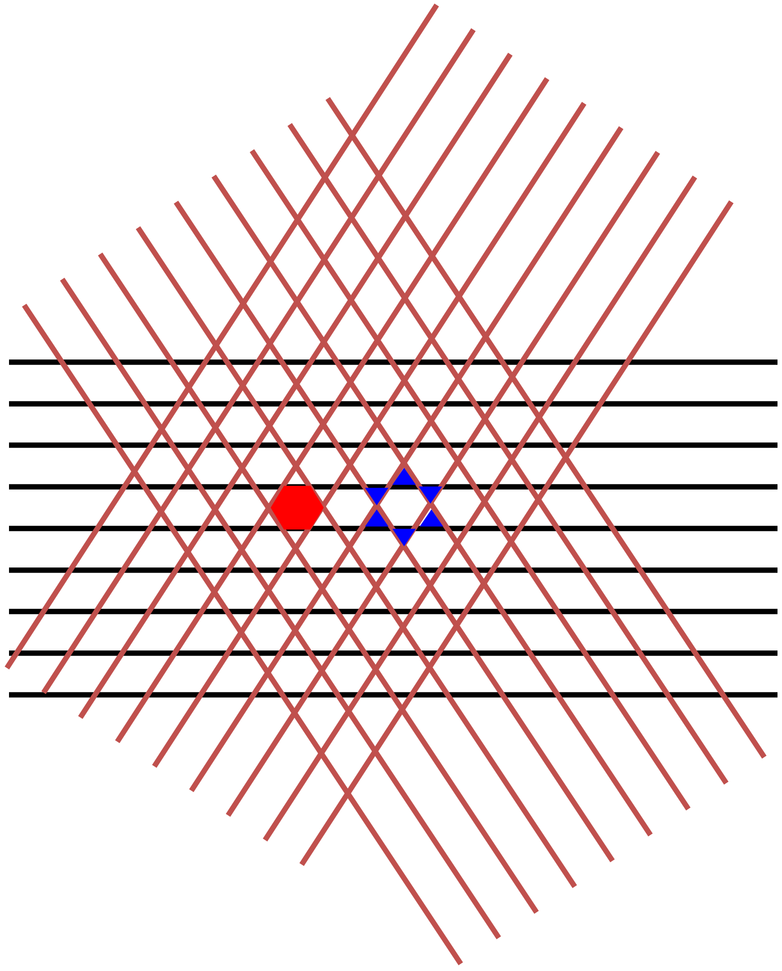


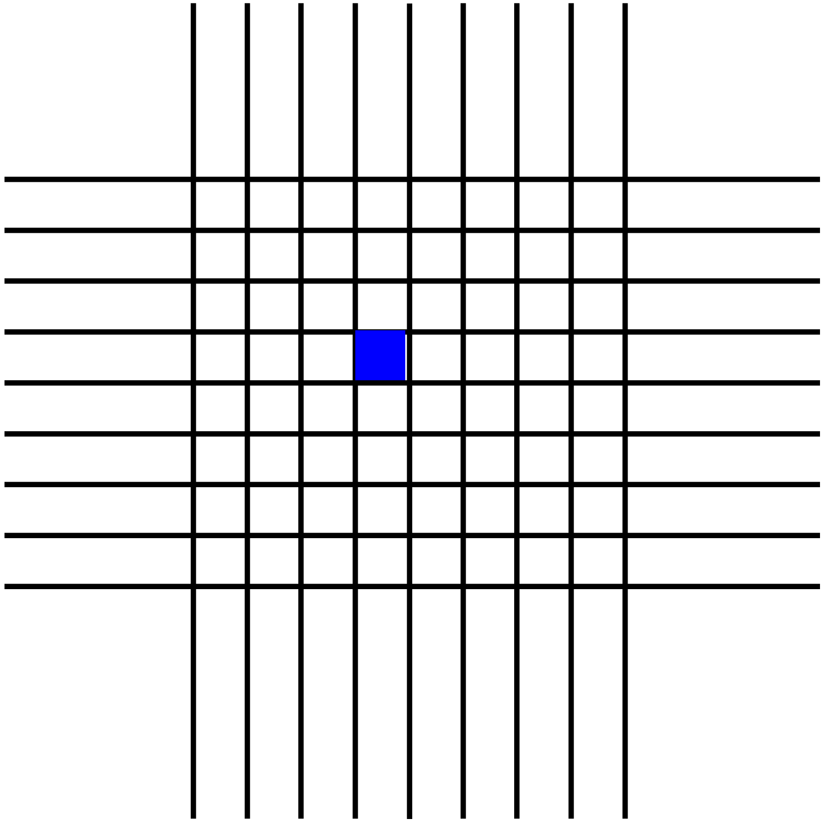
Scanning electron microscope picture of the developed conical structure on excimer laser irradiated polyimide at 74.4 mJ/cm2 fluence.



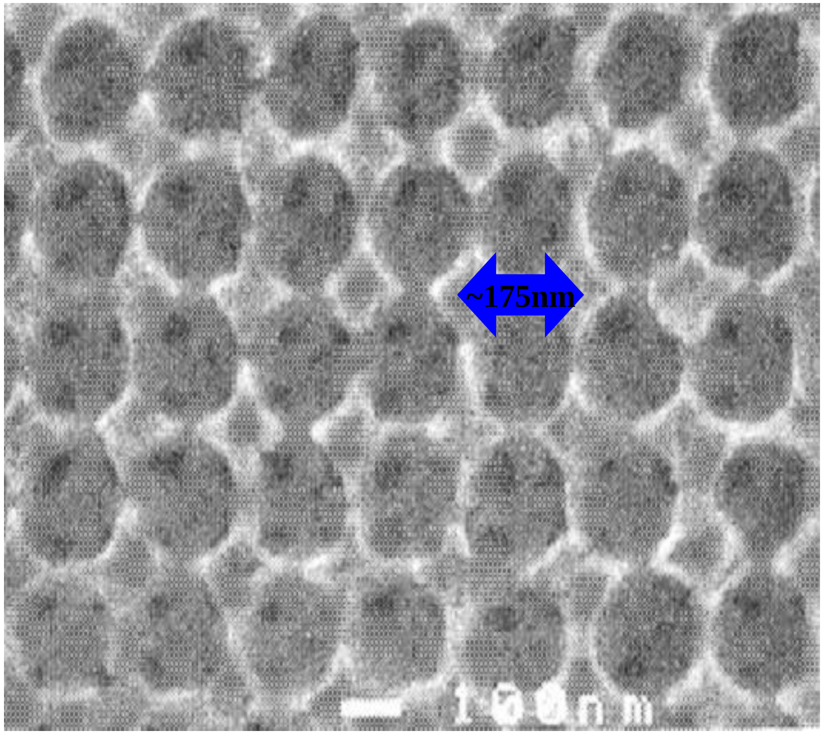
AFM picture of the developed conical structure on excimer laser irradiated polyester at 600 - 1000 mJ/cm2 fluence. Rossier et al. Lausanne Polytechnic Langmuir 1999 15, 5173-5178

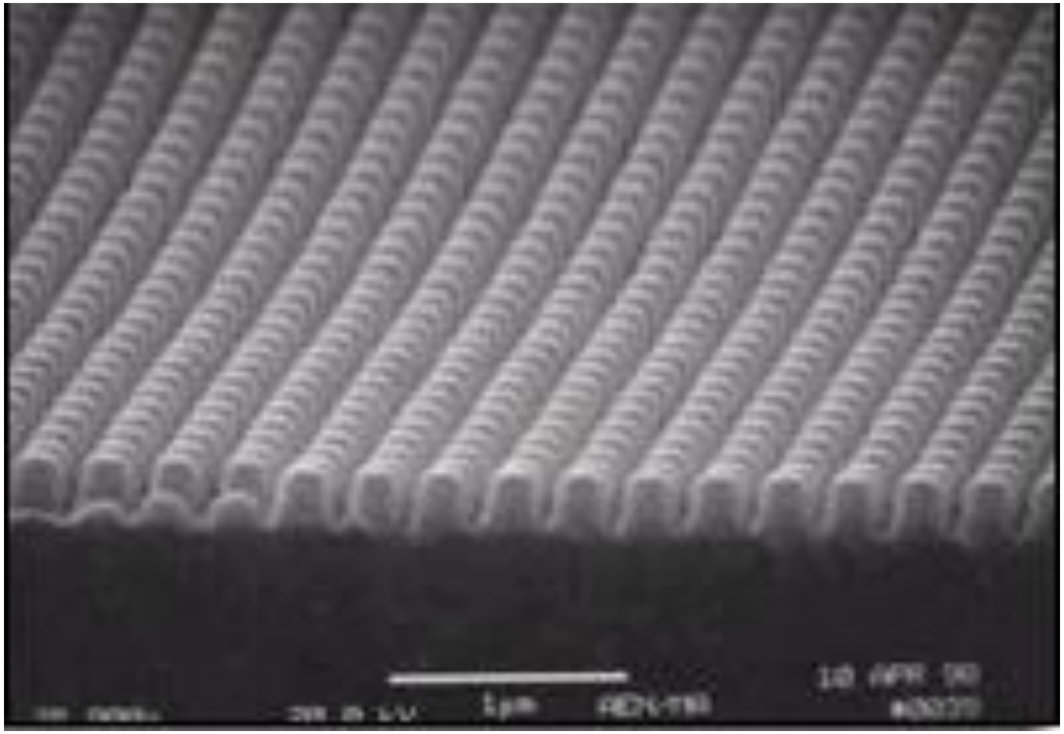
Intersecting gratings





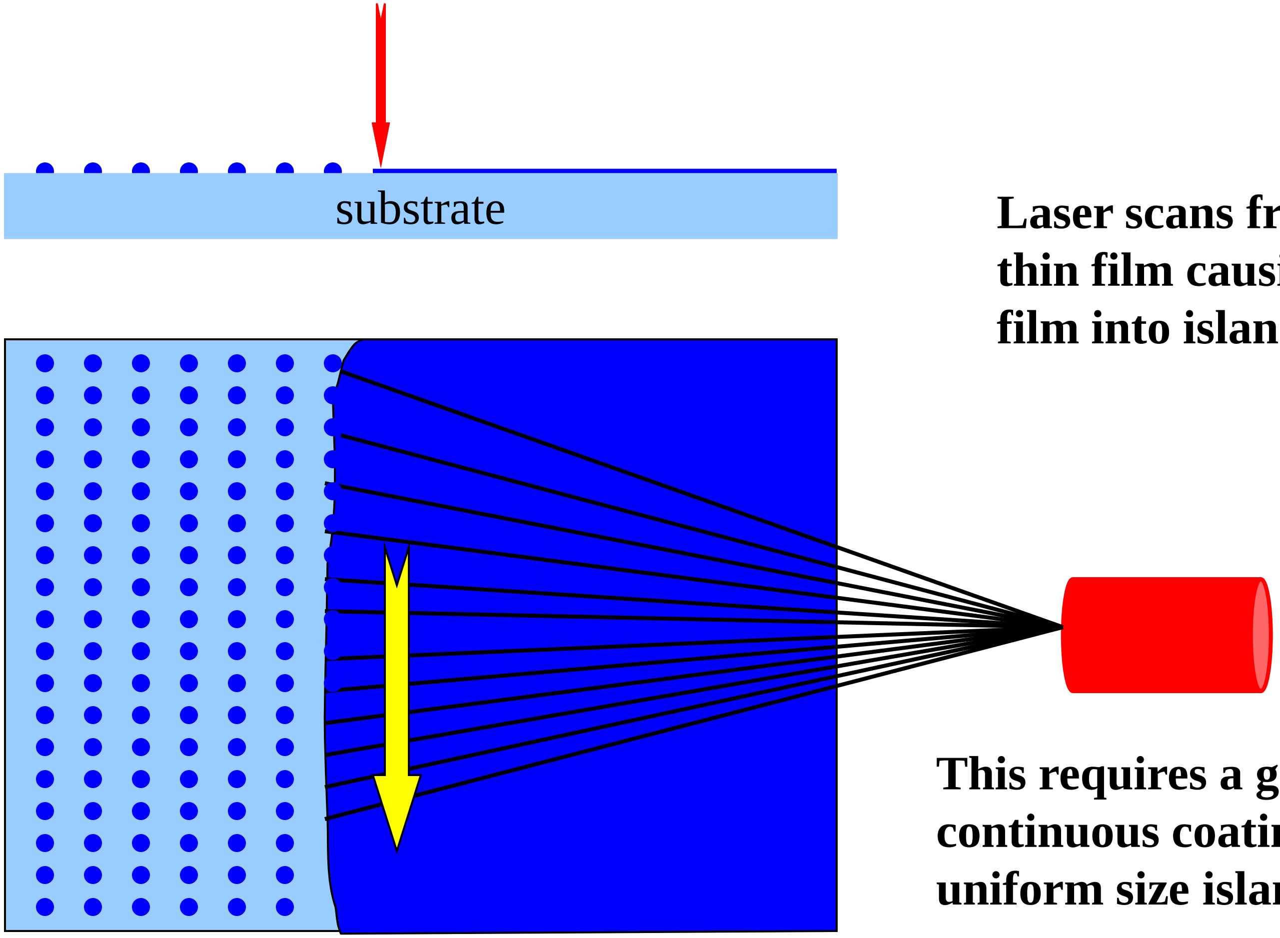
Micrographs - holographic surfaces





300nm pitch replicated holographic motheye Structure produced by Holographix

Laser agglomeration or reticulation



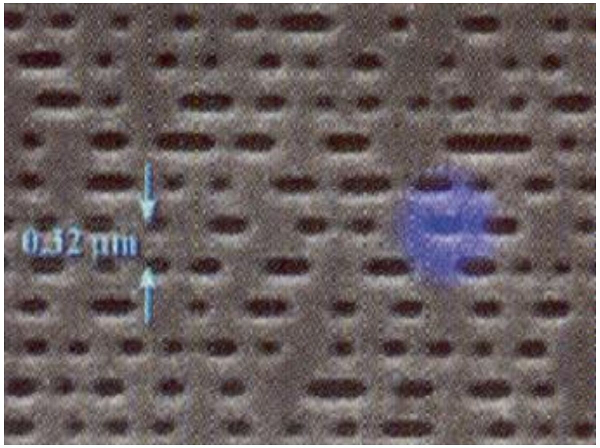
Laser scans from spot to spot on thin film causing reticulation of the film into islands

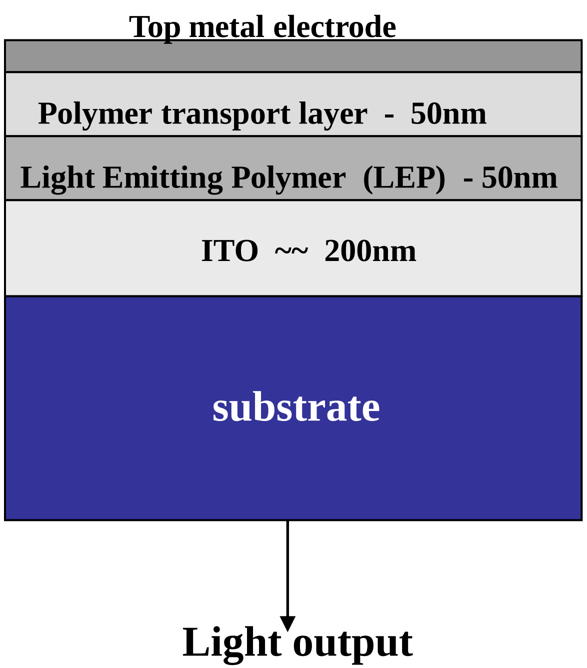
This requires a good quality very thin continuous coatings to shrink into uniform size islands

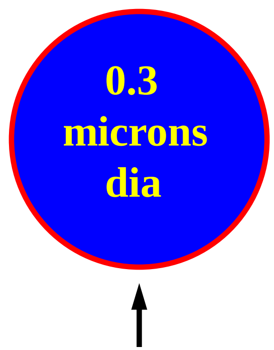
Debris –

the need for cleaning

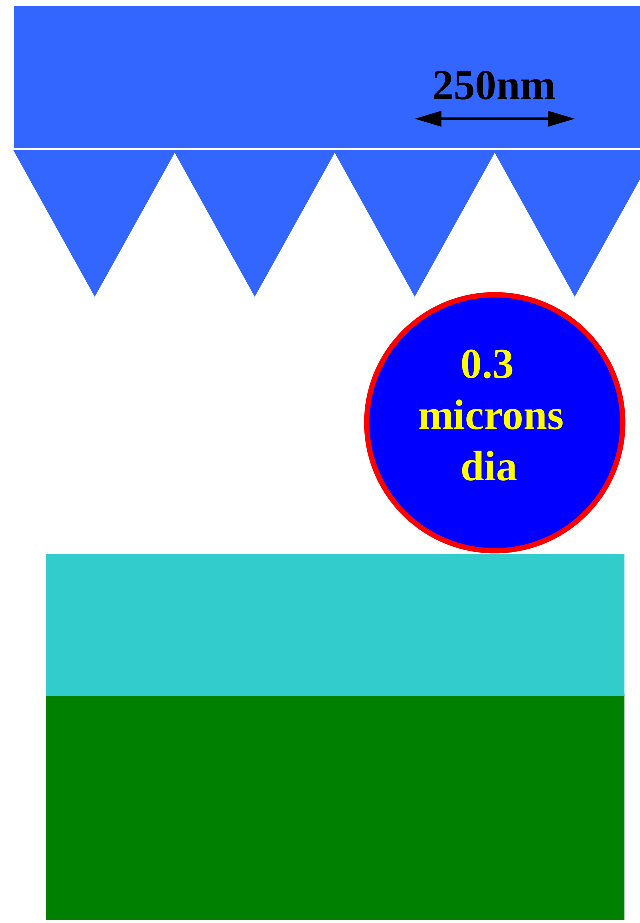
DVR blue laser 400nm
track spacing 0.32 microns



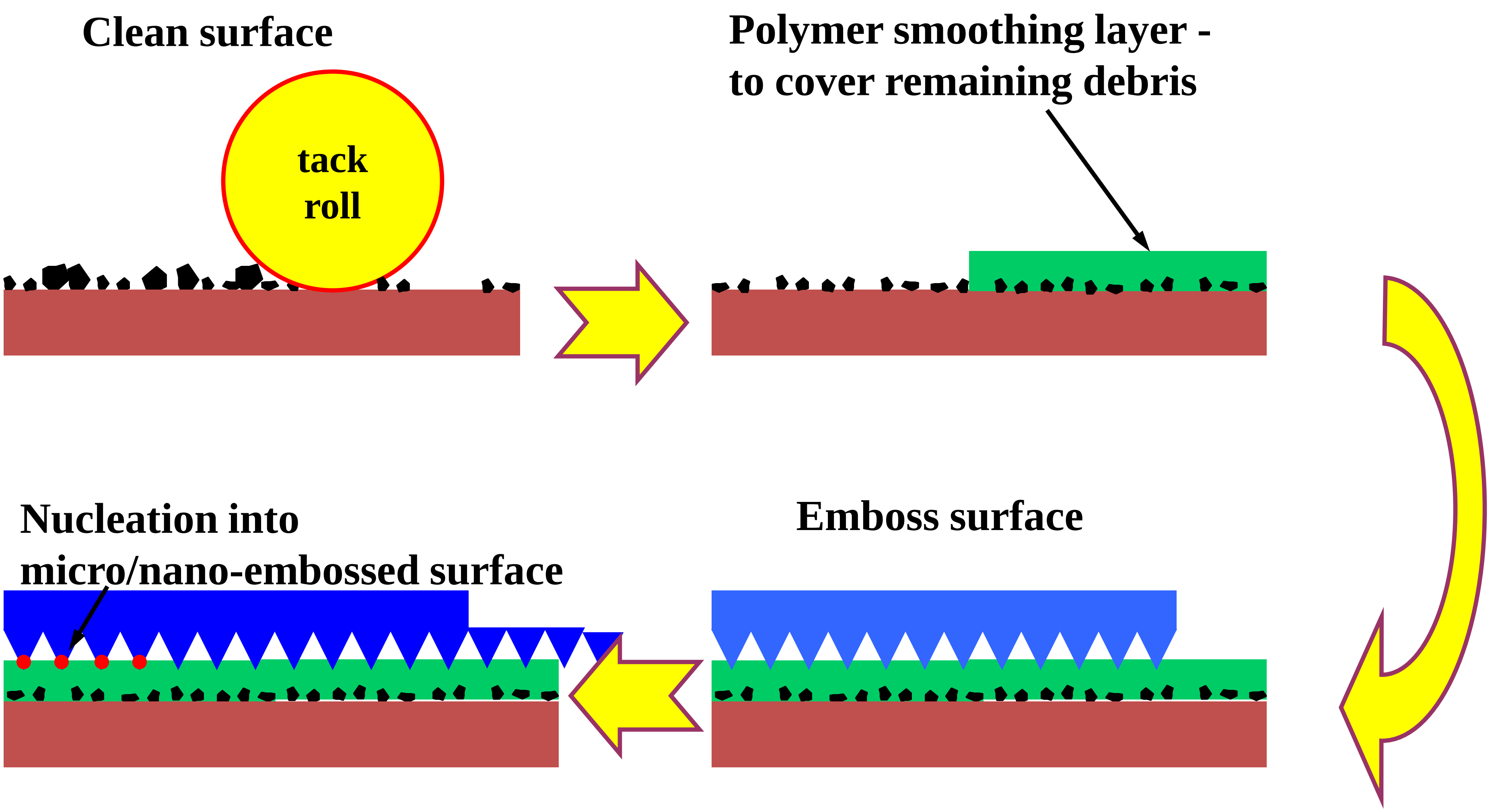




residual debris is of the same size as the total thickness of OLED coatings or pitch of the embossed grating or track spacing of blue laser DVR

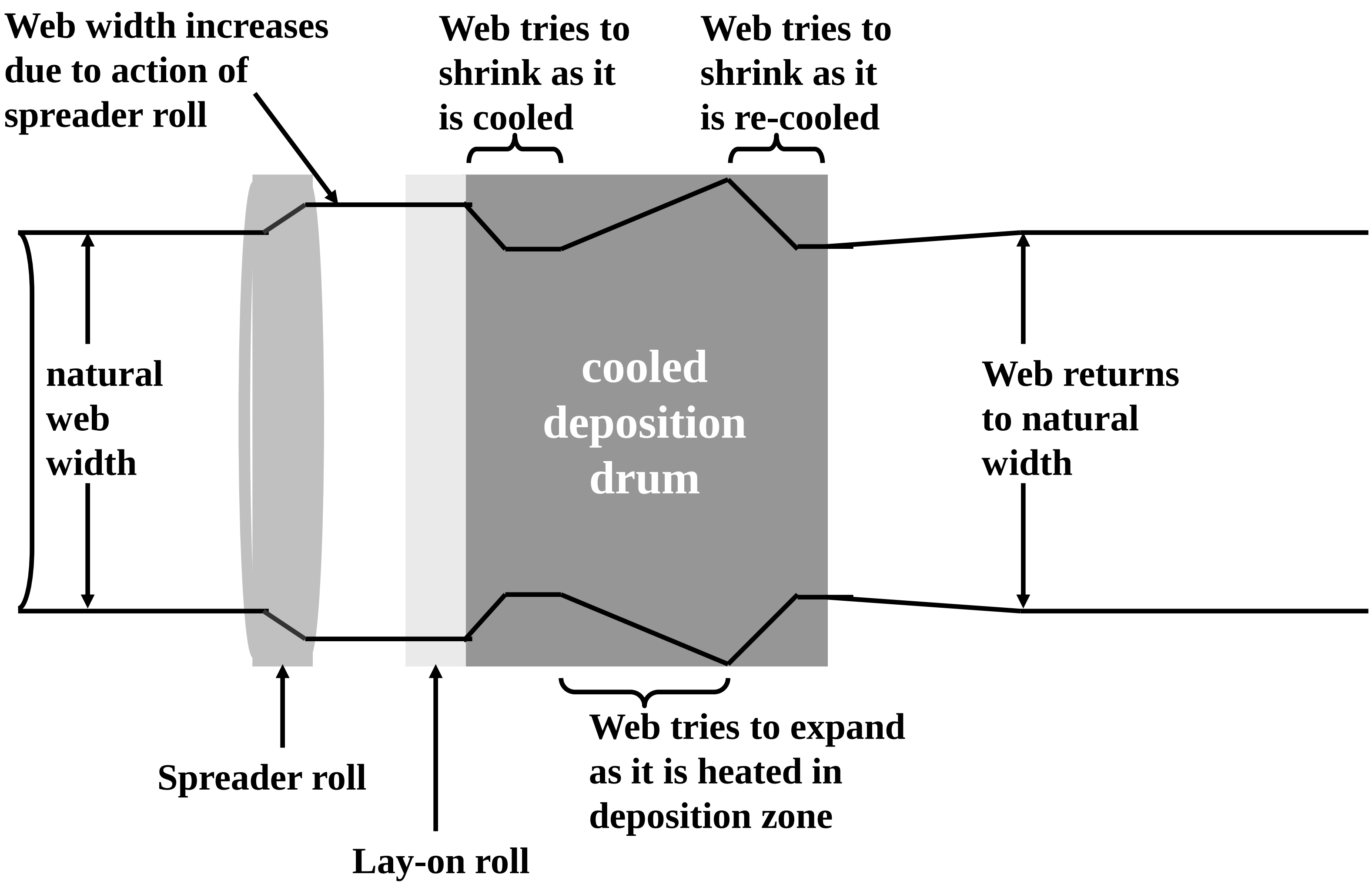


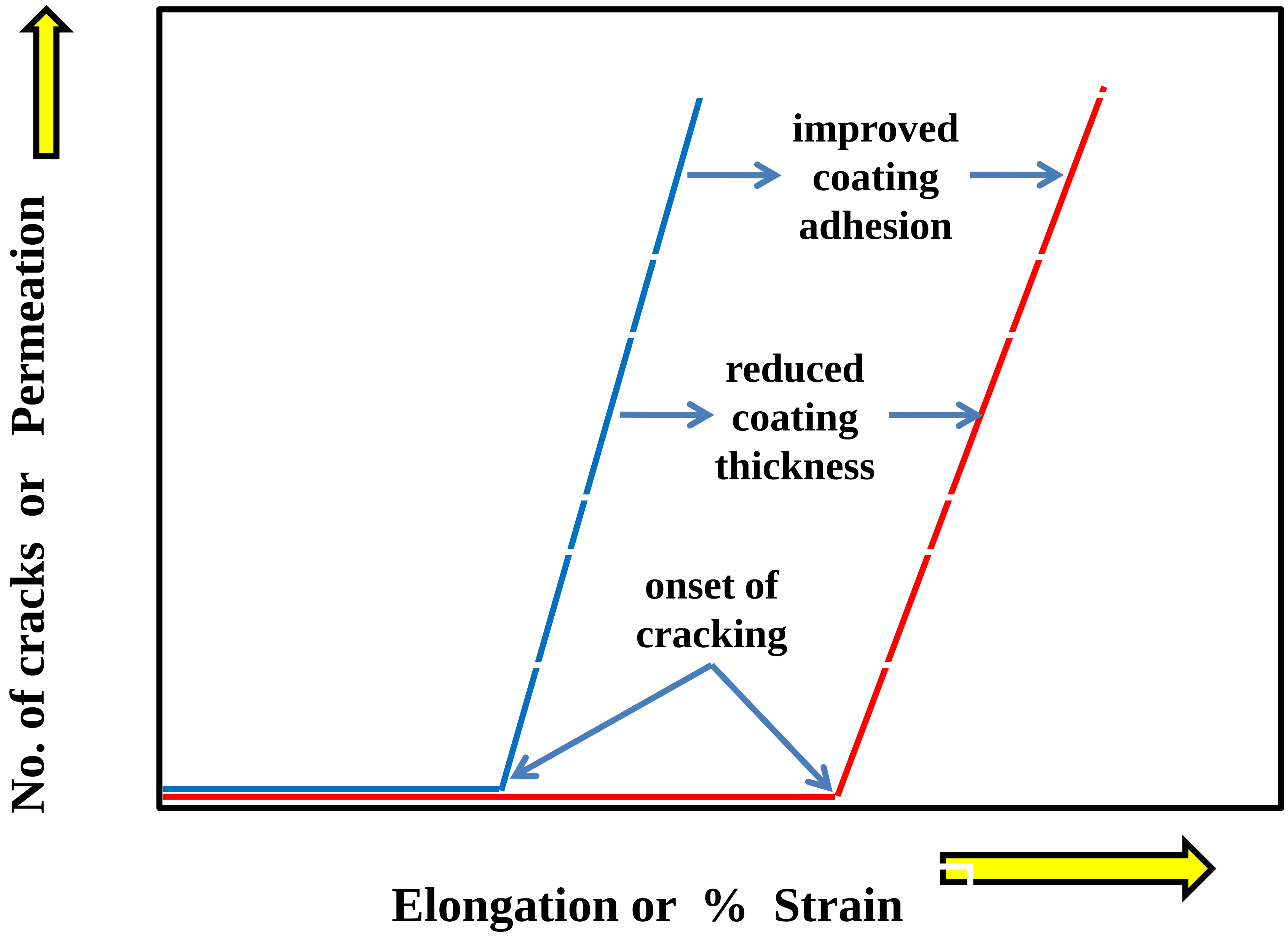
Starting process steps



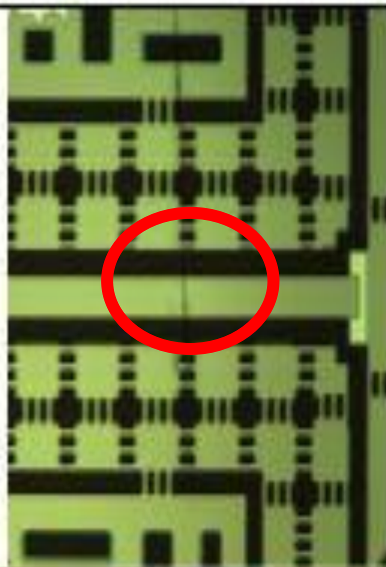
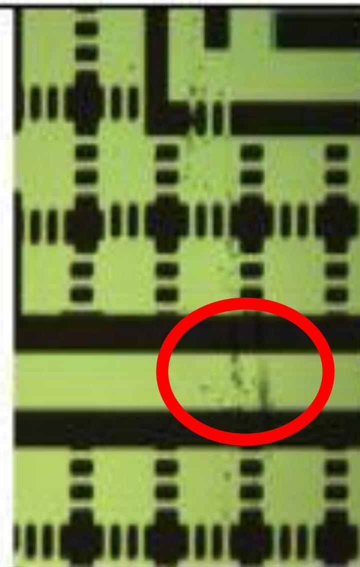
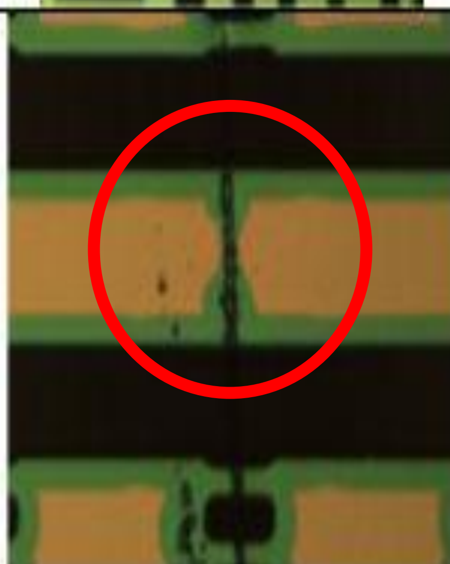
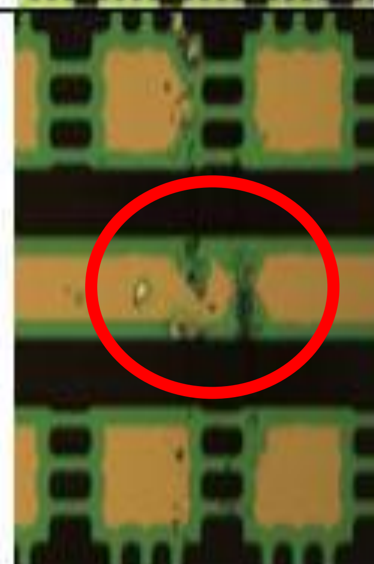
Polymer films

Web dimension changes



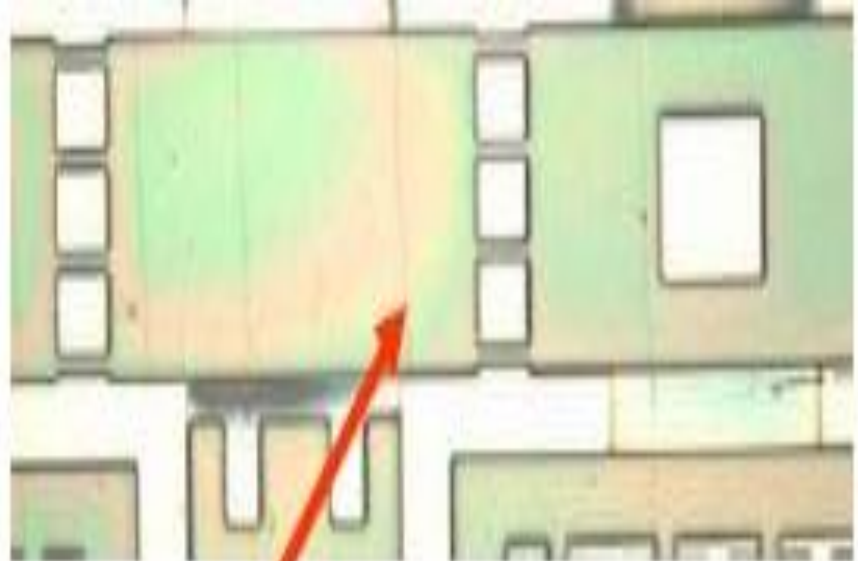


improved coating adhesion
reduced coating thickness
onset of cracking
No. of cracks or Permeation
Elongation or % Strain

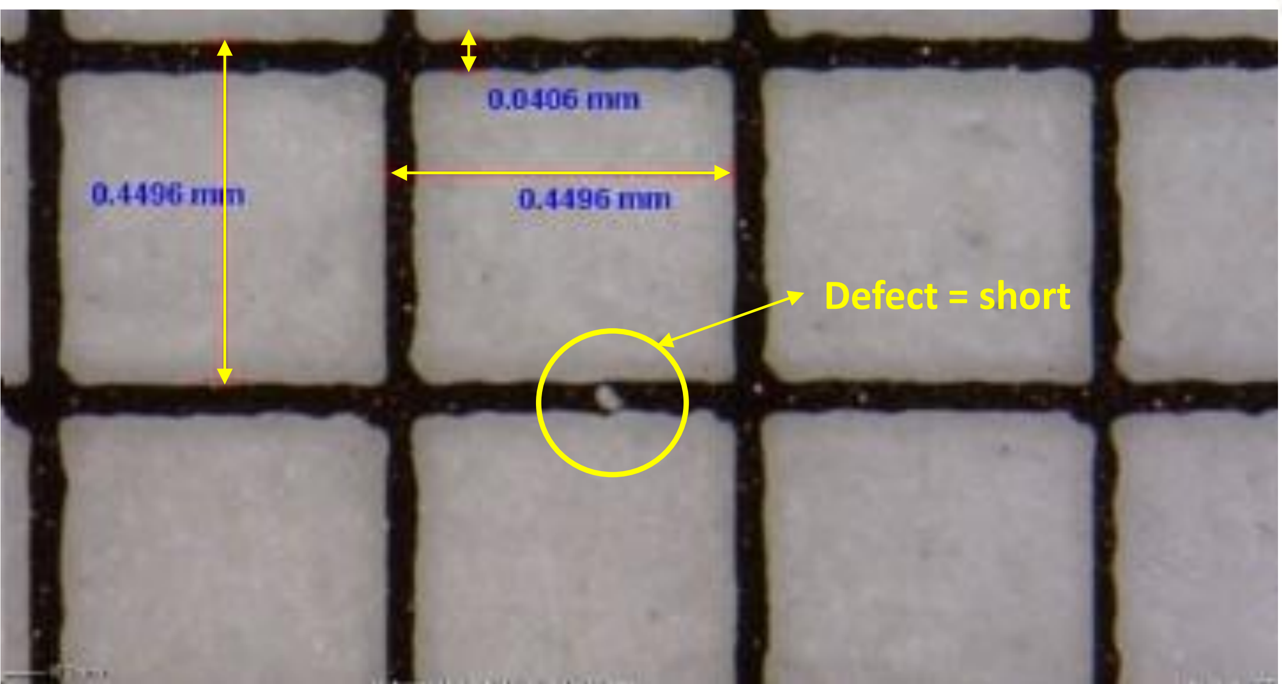
	Scratch	Nodules	Particle embedded in stack
After full processing			
Without top metal			

Source: HP labs. Planarisation of PI substrates for R2R for flex displays

pinhole defect in metal caused by etchant diffusing through pinhole in oxide

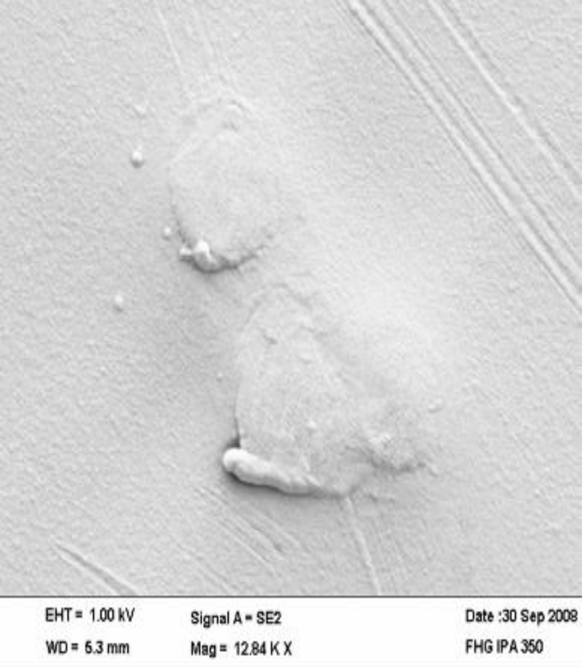


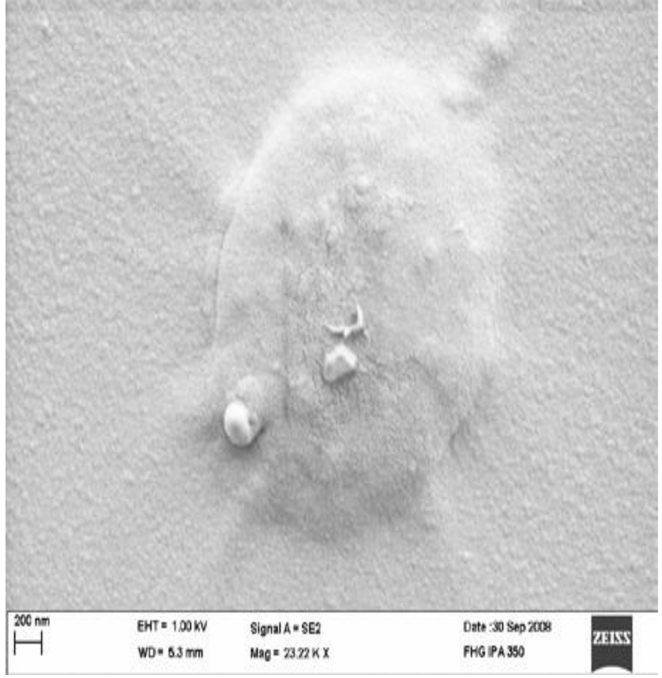
A crack defect typically results from imbalanced deposition stress

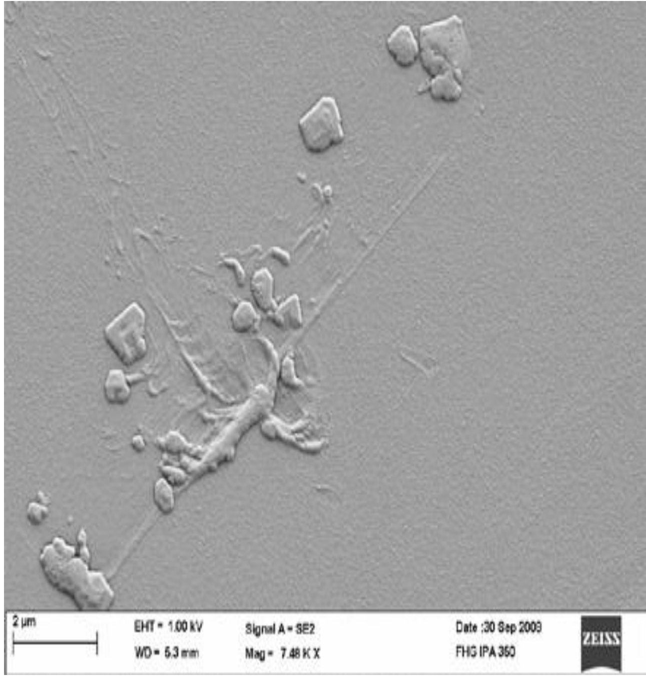


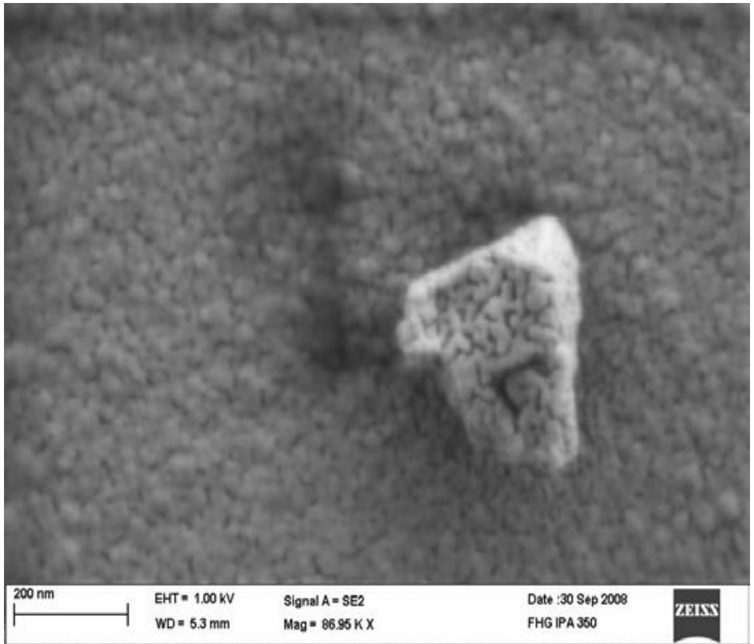
Electronic materials can have poor yields if the surface quality is poor or the tension is not well managed

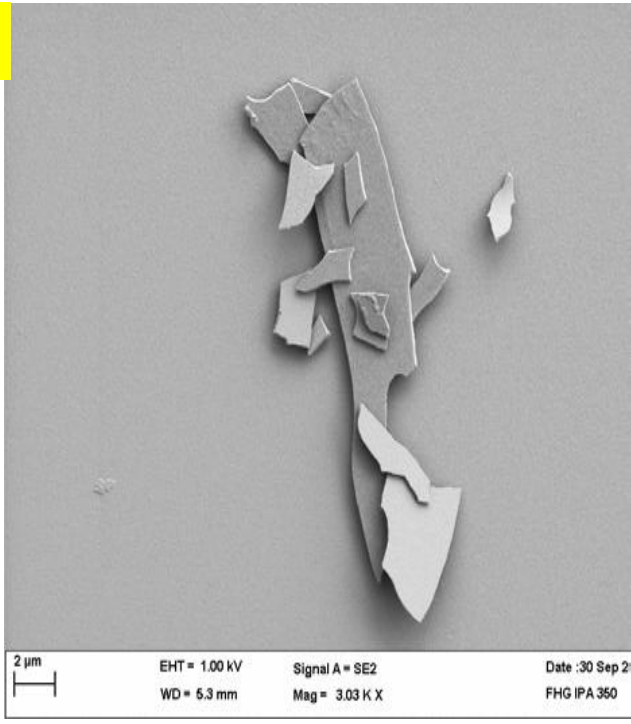
SEM of defects – FEP IVV Freising



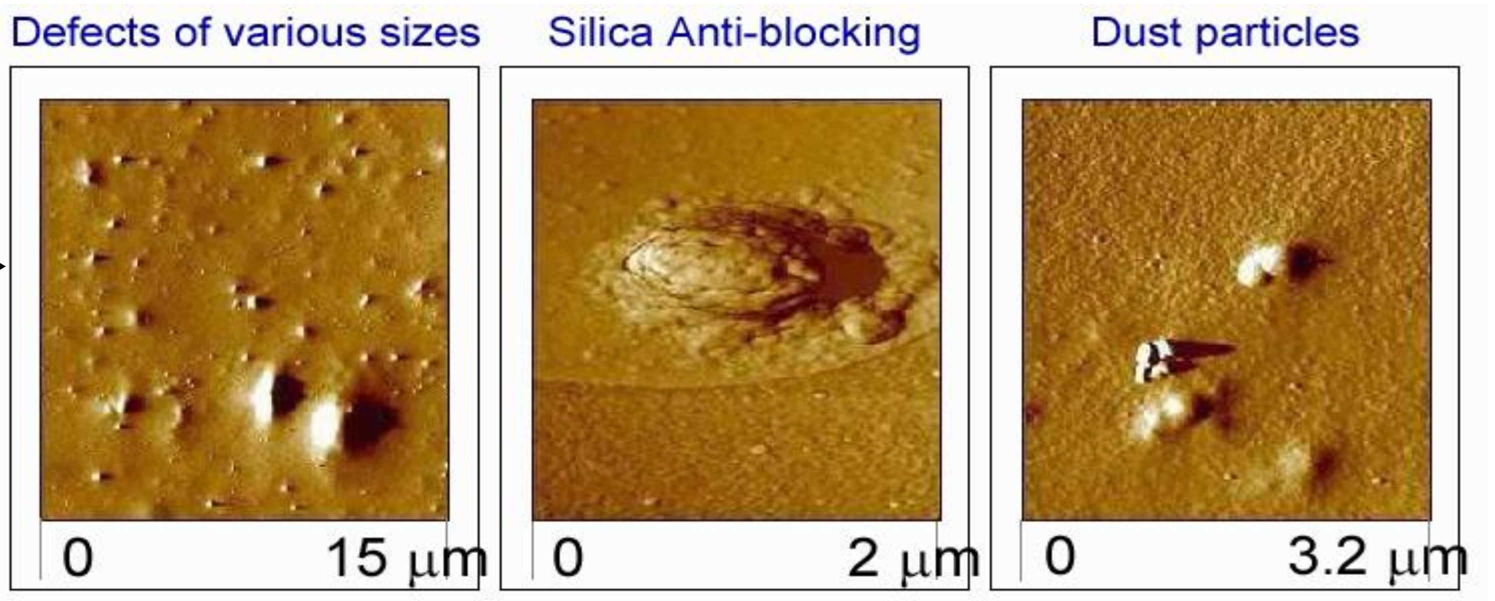




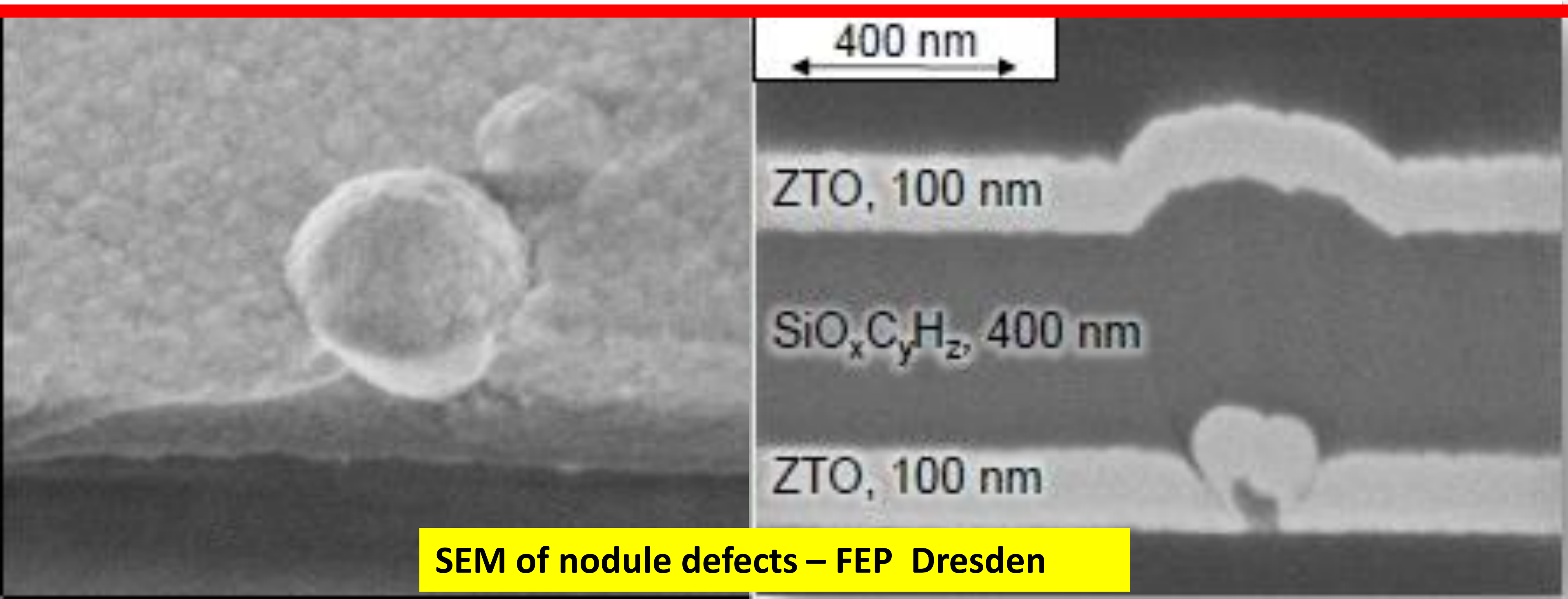




Images courtesy of TetraPak

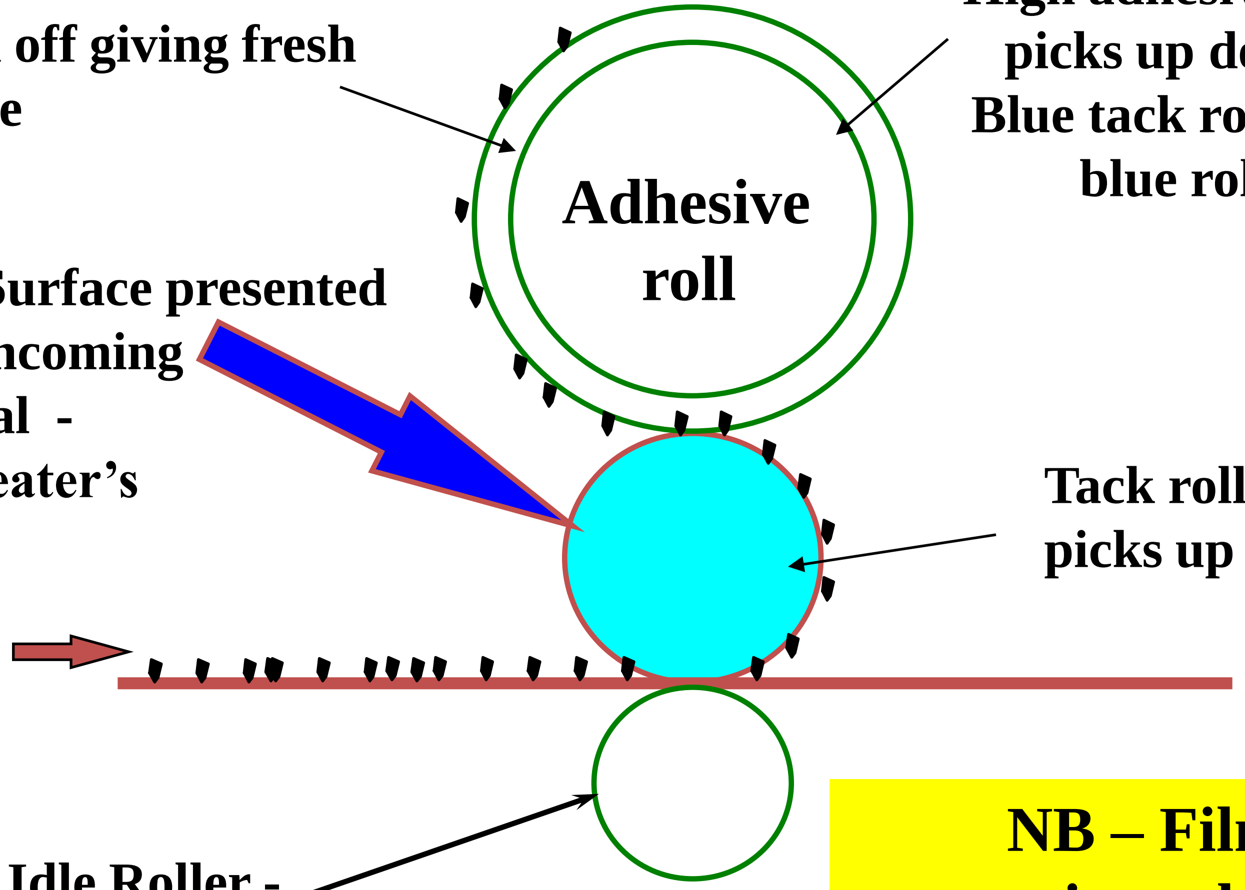


Data from tapping AFM: Amplitude



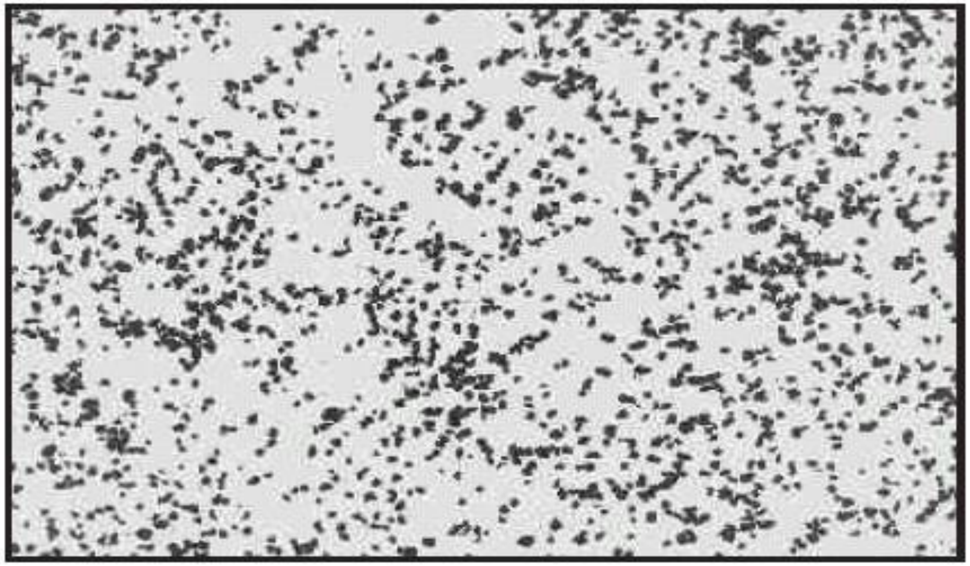
SEM of nodule defects – FEP Dresden

Tack roll cleaning



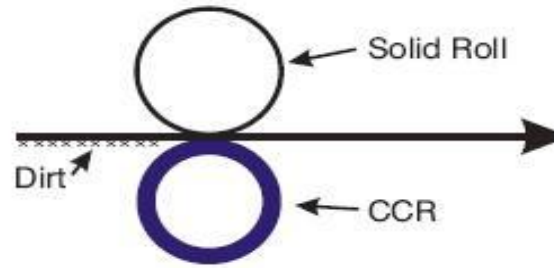
NB – Films will be contaminated on both sides – so BOTH sides need cleaning

Tacky roll cleaning



Before Cleaning
Particle Count = 2828

(10 micron particles on film)
Photographed at 125X magnification

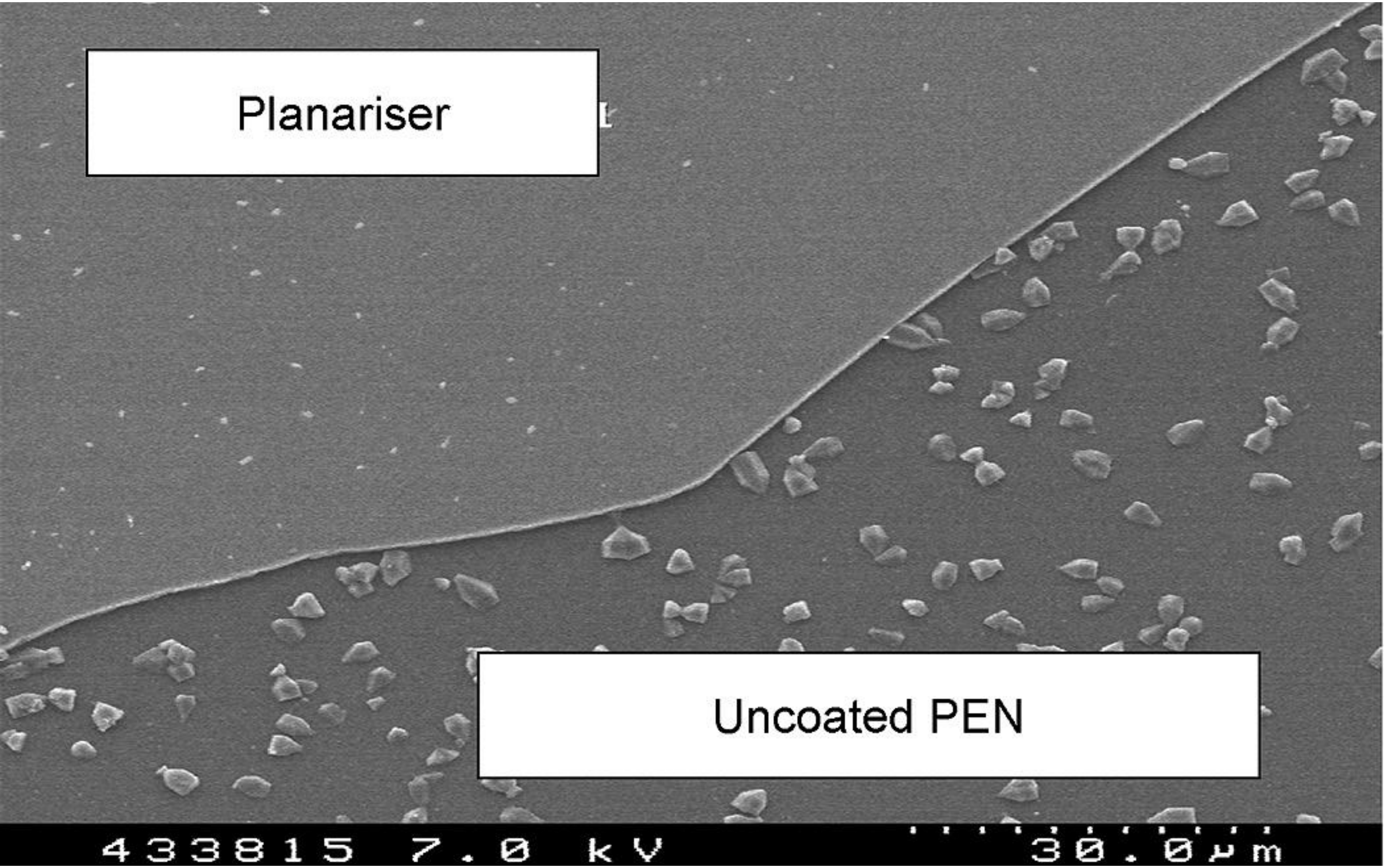


After Cleaning
Particle Count = 87

Images courtesy of PolymagTek

Cleaning Efficiency=96.9%

Planarised substrate



Source: Bill MacDonald DuPont Teijin Films J. SID 15/12, 2007 p1075

Conclusions

- Choose polymer type
- Heat stabilise web
- Clean surface
    - Gross clean – particulates
- Coat planarising layer
- Surface treatment (plasma) – optimise adhesion
- Deposit inorganic coating
    - option – densify coating
- Coat protective layer
- Throughout manage tension and heat load

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Thank you for listening

Charles A. Bishop

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