DisChem
CHEMISTRY FOR ADVANCED LITHOGRAPHY

DisCharge

ELECTRON BEAM LITHOGRAPHY ANTI-CHARGING AGENT

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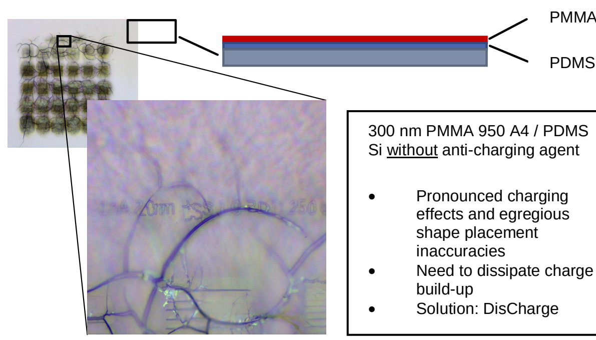
DisCharge is an anti-charging agent used is electron-beam lithography to prevent charge accumulation on electrically insulated substrates. DisCharge is available in both water and IPA based formulations for optimal resist comparability. DisCharge may also be used as removable, non-destructive conductive agent in SEM imaging.

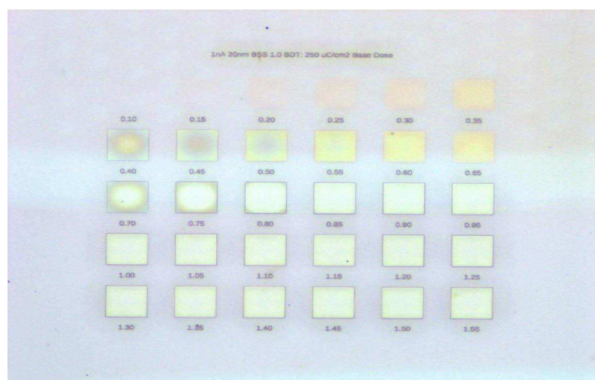
DisCharge Advantage

- ✓ Efficient charge dissipation in e-beam lithography on a broad range of resist materials (novolac resist, PMMA, HSQ, mr-PosEBR, CSAR62, ZEP520A,)
- ✓ Improves shape fidelity, positioning and line pitch of e-beam resist on insulated substrate materials (fused silica, quartz, PDMS, etc.)
- ✓ Competitively priced Ideal for research and industrial applications
- ✓ Available in water and IPA based formulations
- ✓ Excellent wetting properties
- ✓ Easy residue-free removal by water rinse at room temperature.
- ✓ Manufactured in USA with global distribution network
- ✓ Permanently charged non-polyaniline polymer provides high stability and longer shelf life (2 years)



300 nm PMMA 950 A4 / PDMS
Si without anti-charging agent

- Pronounced charging effects and egregious shape placement inaccuracies
- Need to dissipate charge build-up
- Solution: DisCharge



With DisCharge, no charge accumulation is observed. The structure appears as expected with no hard to PDMS from sudden dielectric breakdown.

DisCharge Properties

Parameter	DisCharge H2O	DisCharge IPA
Solvent base	Water	Isopropanol
Film Thickness	40nm (1000 rpm)	70nm (4000 rpm)
Conductivity	1200 µS/cm3	1200 µS/cm3
Refractive Index	1.3357	1.3816
Flash Point (closed cup)	- Non-flammable	12ºC
Total Dissolved Solids	565 ppm	60 ppm
Shelf Life (room temperature)	2 years	2 years

DisCharge Selection and Availability

DisCharge is available in both water and IPA based formulations for optimal resist compatibility. Water borne DisCharge is recommended for most applications. The IPA solvent based solution is provided for applications where the resist material may be sensitive to water. DisCharge is available in sizes ranging from 25 mL to 4 liter bottles, making it ideal for both research and industrial needs.

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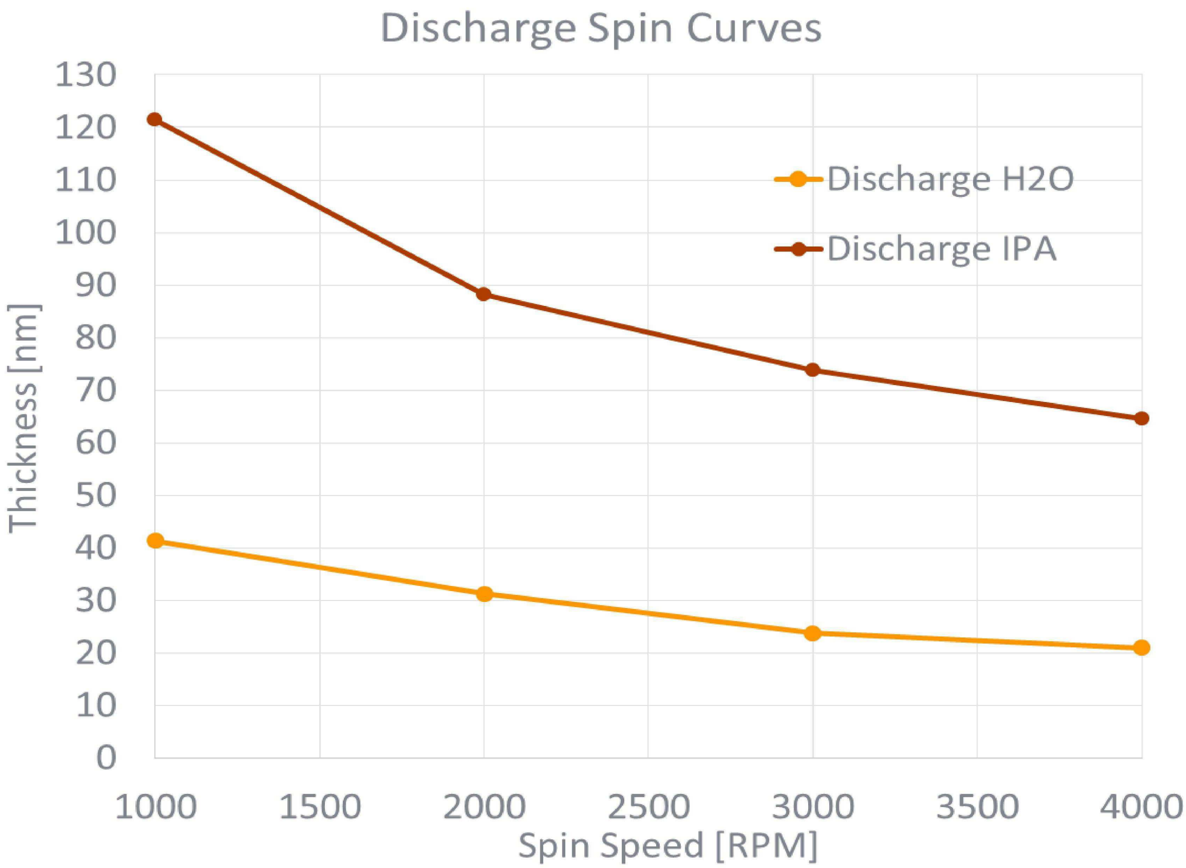


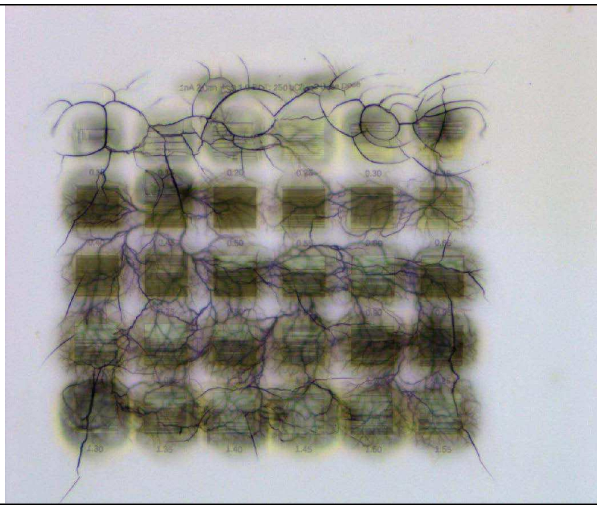
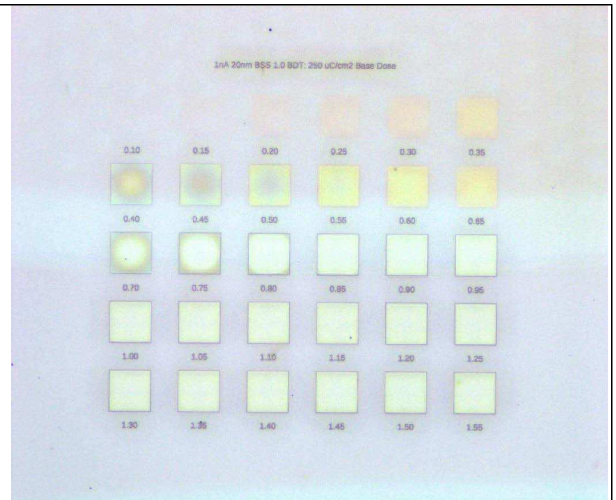
DisCharge Application and Removal

1. Spin coat and pre-bake resist per protocol.
2. Allow wafer / sample to cool to room temperature.
3. Spin coat DisCharge to desired thickness per the spin curve diagram above. No soft bake is required. The DisCharge film remains tacky to the touch - avoid touching the film as it may smudge. Film should have gloss finish.
4. EBL Tool: Mount sample with grounding clip touching the surface of the sample. Expose desired pattern.
5. After resist exposure, remove the DisCharge film using one of the methods below:
    - **a. Spin Rinse Removal**
        1. Mount wafer / sample in spinner and set for speed of 3000 RPM for 60 seconds
        2. Initiate spin and rinse with generous amounts of DI water or IPA.
        3. Spin dry or blow dry with nitrogen.
    - **b. Sink Rinse Removal**
        1. Firmly hold the sample and rinse with running DI water over a sink for 30-60 seconds.
        2. Thoroughly dry the sample using nitrogen blow dry.
        - **c. Solvent Rinse Removal (IPA)**
            1. Firmly hold the sample and rinse with a steady stream of isopropyl alcohol for 30-60 seconds over a beaker to capture solvent.
            2. Thoroughly dry the sample using nitrogen blow dry.
6. Develop resist as normal.

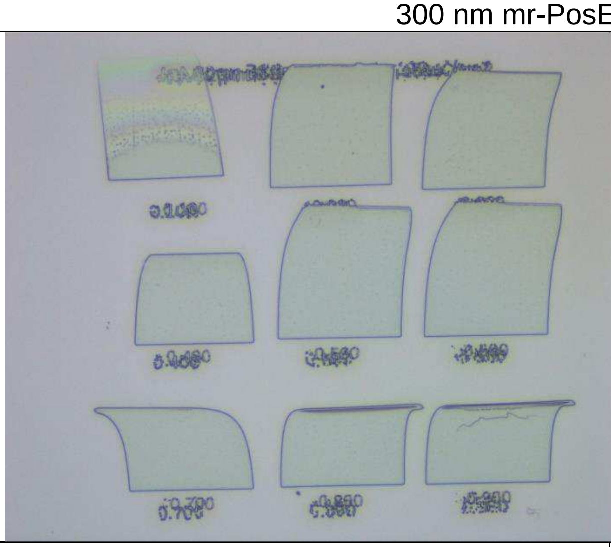
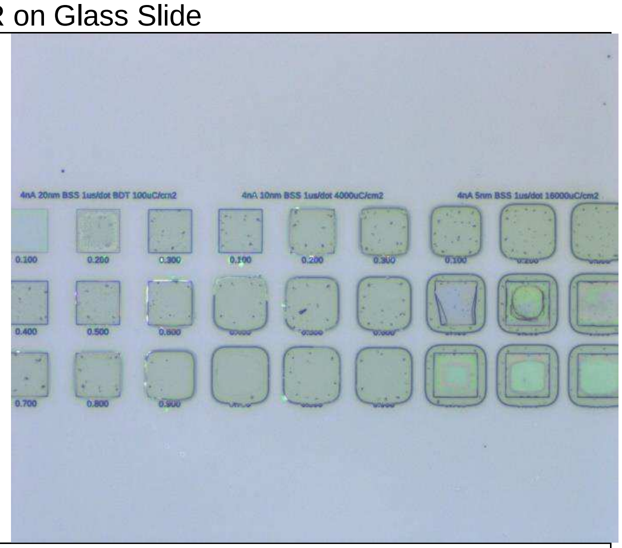
Evidence of DisCharge Anti-Charging Properties

The follow images provide evidence of the effectiveness of DisCharge as effective tool for use as a charge dissipation agent in electron beam lithography. Exposures were performed on various resist materials using the Elionex ELS-7500EX 50 keV. Test structures consist of 60 micron squares exposed at various doses using a 20 nm beam step (shot pitch) with 1 nA beam current. Experiments were performed at the University of Pennsylvania's Singh Center for Nanotechnology Quattrone Nanofabrication Facility. Special thanks are given to Gerald G. Lopez, PhD and Glen Villafranca.

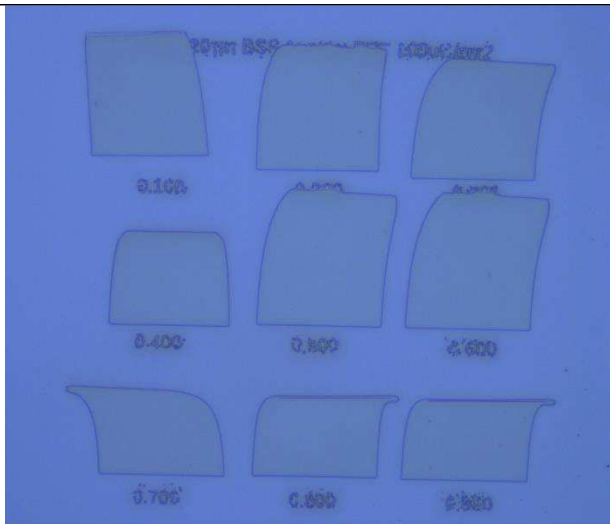
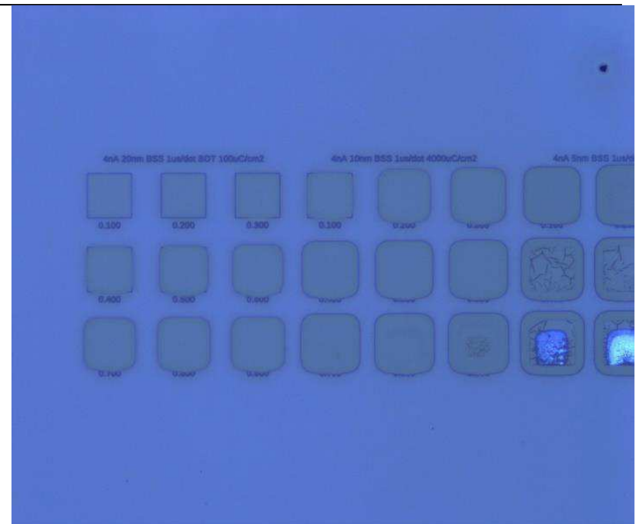
300 nm PMMA 950 A4 / 1 mm PDMS / bulk Si

	
Without DisCharge: charge accumulation and sudden charge dissipation caused by exceeding the dielectric breakdown strength of the PDMS to the Si substrate resulting in significant cracking of the resist.	WITH DisCharge: no charge accumulation, resulting in expected image with no harm to the PDMS

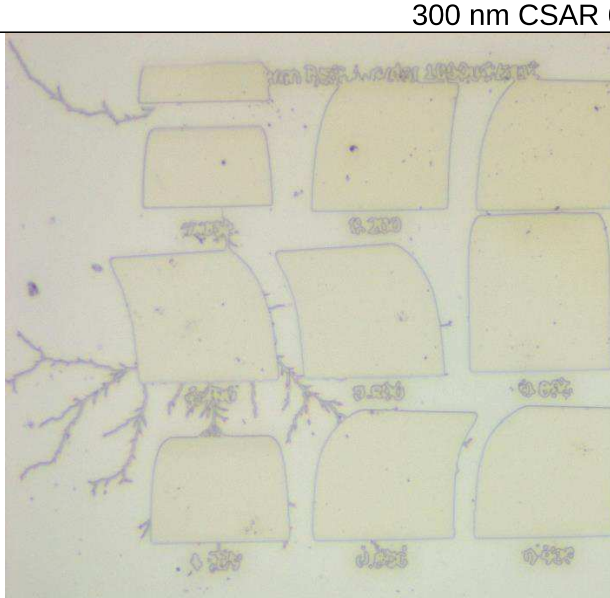
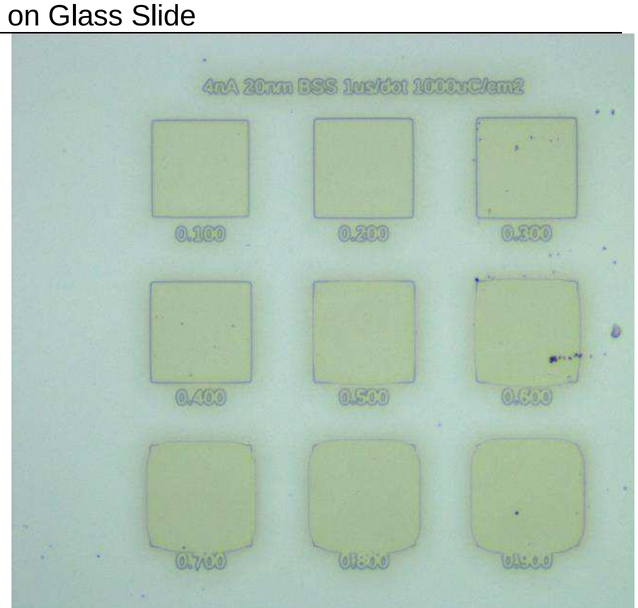
300 nm mr-PosEBR on Glass Slide

	
Without DisCharge: charge accumation leading to poor shape fidelity of the contrast curve pattern.	WITH DisCharge: no charge accumulation is observed. The structure appears as expected. Crosslinking of the positive resist is especially observed at high doses.

200 nm ZEP520A on Glass Slide

	
Without DisCharge: charge accumation leading to poor shape fidelity of the contrast curve pattern.	WITH DisCharge: no charge accumulation is observed. The structure appears as expected. Crosslinking of the ZEP520A resist is especially observed at high doses.

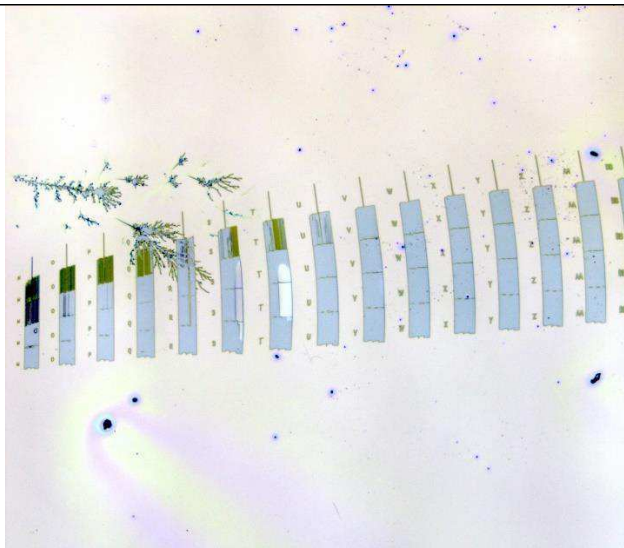
300 nm CSAR 62 on Glass Slide

	
Without DisCharge: charge accumation leading to poor shape fidelity of the contrast curve pattern.	WITH DisCharge: no charge accumulation is observed. The structure appears as expected. Crosslinking of the CSAR62 resist is especially observed at high doses.

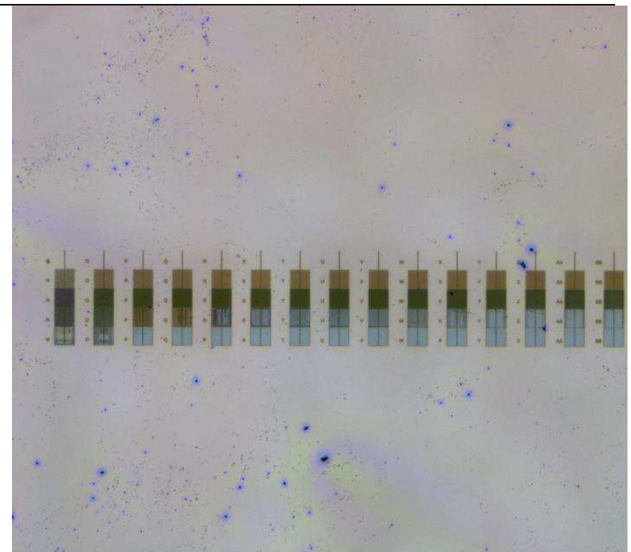
Nanoscale Impact of DisCharge

DisCharge efficacy was tested at the nanoscale using tower patters in a dose matrix using 300 nm ZEP520A atop fused silica. The tower patterns consist of 300 nm line space patterns at various pattern densities.

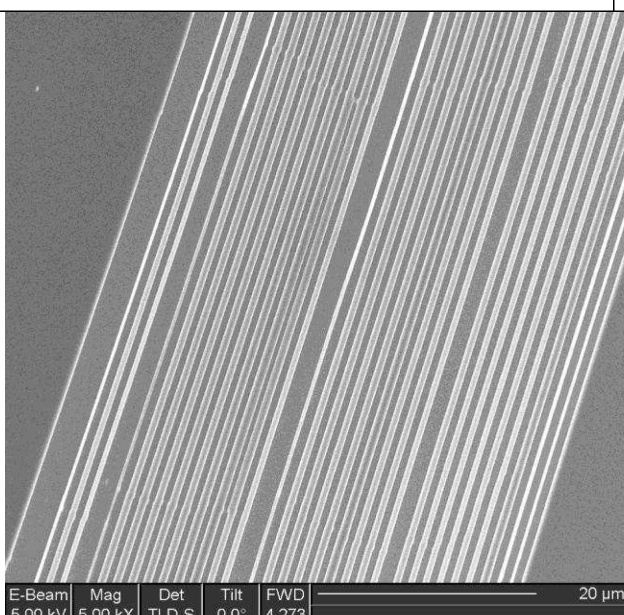
300 nm ZEP520A on Fused Silica



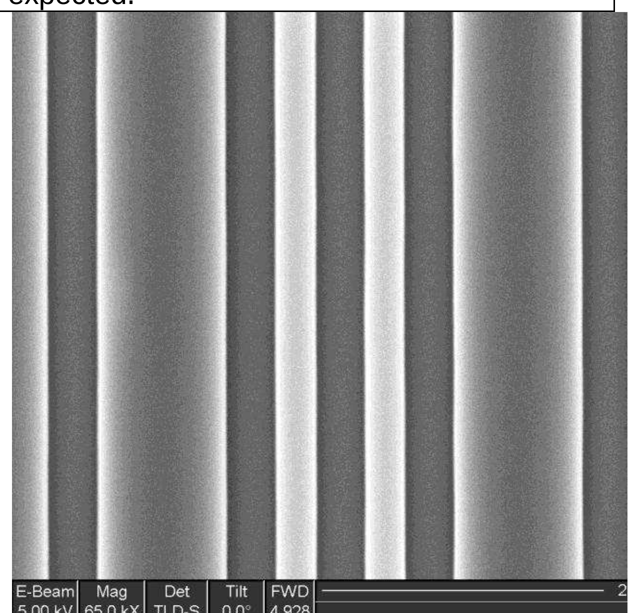
Without DisCharge: charge accumulation resulting in poor shape fidelity of the tower pattern.



WITH DisCharge: No charge accumulation is observed. The structures appear as expected.



Without DisCharge: charge accumulation resulting in poor shape fidelity of the tower pattern.



WITH DisCharge: No charge accumulation is observed. The structures appear as expected.

Note: The original paper providing these results and images, *DisCharge: Spin-On Anti-Charging Agent for Electron Beam Lithography*, may be downloaded for the University of Pennsylvania Scholarly Commons at: https://repository.upenn.edu/cgi/viewcontent.cgi?article=1050&context=scn_protocols