Paper Review

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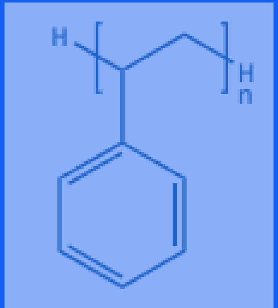
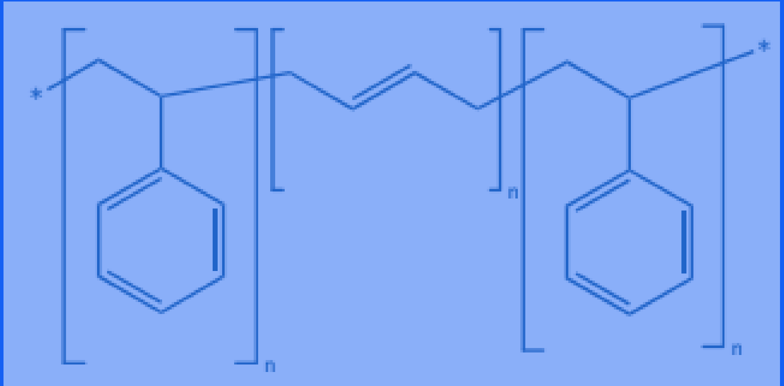
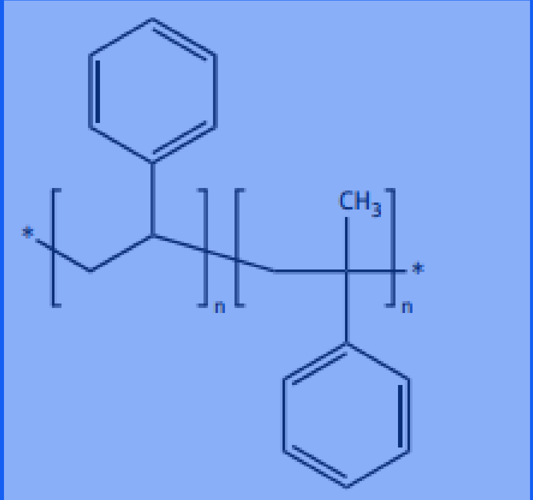
09 Dec 2019

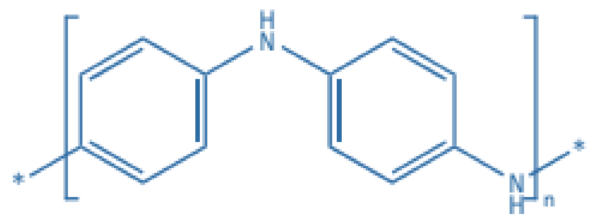






Good electrical conductivity and environmental stability for biomedical and technological applications

Polyaniline (PANI)



However, the poor solubility of PANI in common solvents and low molecular weight interferes with electrospinning into uniform fibers

Sironi, A., Marinotto, D., Riccardi, C., Zanini, S., Guerrini, E., Della Pina, C., & Falletta, E. (2015). Effect of salicylic acid and 5-sulfosalicylic acid on UV-Vis spectroscopic characteristics, morphology, and contact angles of spin coated polyaniline and poly(4-aminodiphenylaniline) thin films. Journal of Spectroscopy, 2015. https://doi.org/10.1155/2015/609175

Previous Work (2009) …

e-Polymers **2009**, no. 114

http://www.e-polymers.org
ISSN 1618-7229

Electrospinning of polyaniline-polyacrylonitrile blend nanofibers

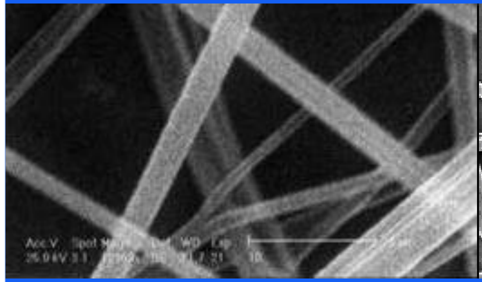
Fatemeh Raeesi, Mahdi Nouri, Akbar Khodaparast Haghi*

*Department of Textile, University of Guilan, Rasht, Iran, P.O. Box 41625-3756; fax: +98-131-6690271; email: mnouri69@guilan.ac.ir

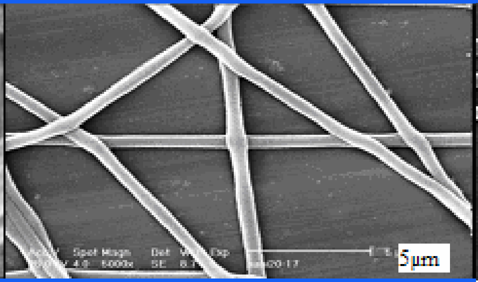
(Received: 08 November, 2008; published: 21 October, 2009)

Typically, the use of an insulating copolymer with high molecular weight is expected to act as a remedy

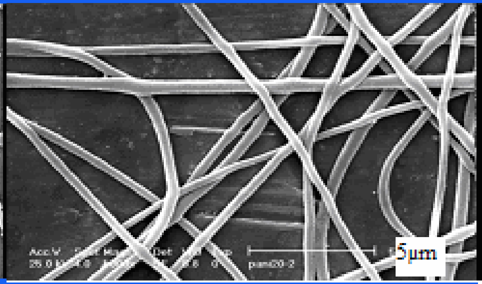
However, the presence of a nonconducting polymer modifies the properties of PANI



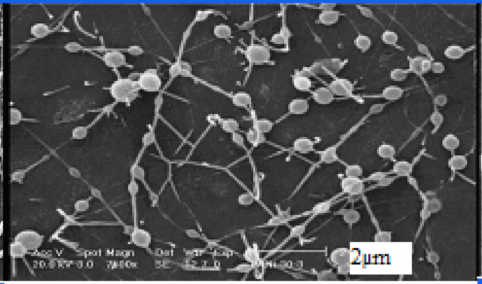
100% PAN
Fiber diam: 652nm



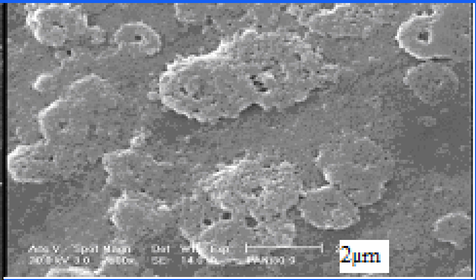
10% PANI w/PAN
Fiber diam: 602nm



20% PANI w/PAN
Fiber diam: 425nm



30% PANI w/PAN
Fiber diam: 164nm



100% PANI
Fiber diam: <NA>

Raeesi, F., Nouri, M., & Haghi, A. K. (2009). Electrospinning of polyaniline-polyacrylonitrile blend nanofibers. E-Polymers, (October). https://doi.org/10.1515/epoly.2009.9.1.1350
Sironi, A., Marinotto, D., Riccardi, C., Zanini, S., Guerrini, E., Della Pina, C., & Falletta, E. (2015). Effect of salicylic acid and 5-sulfosalicylic acid on UV-Vis spectroscopic characteristics, morphology, and contact angles of spin coated polyaniline and poly(4-aminodiphenylaniline) thin films. Journal of Spectroscopy, 2015. https://doi.org/10.1155/2015/609175

The Paper (2012) …

Polyaniline nanofibers: Towards pure electrospun PANI

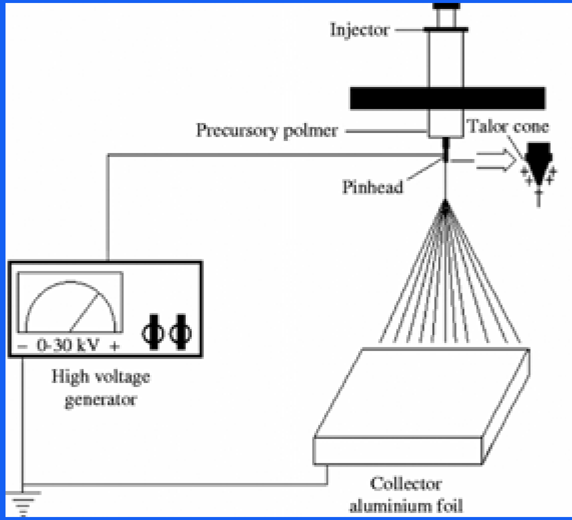
P. Frontera, C. Busacca, P. Antonucci, M. Lo Faro, E. Falletta et al.

Citation: AIP Conf. Proc. **1459**, 253 (2012); doi: 10.1063/1.4738460

View online: http://dx.doi.org/10.1063/1.4738460

"In this work we report the preparation of highly pure polyaniline fibers by electrospinning process."

"Here we report a route to prepare PANI fibres reducing the PEO amount from 1 to 0% w/w with respect to the amount of PANI."

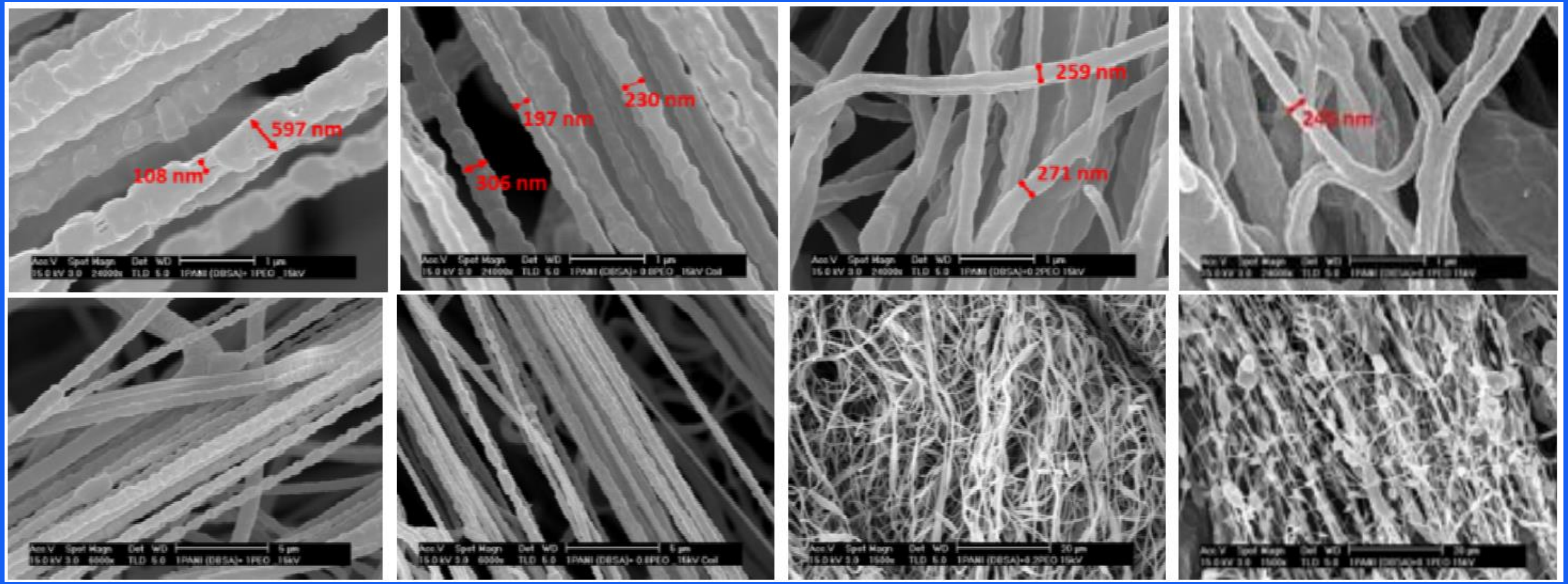


Frontera, P., Busacca, C., Antonucci, P., Faro, M. Lo, Falletta, E., Pina, C. Della, & Rossi, M. (2012). Polyaniline nanofibers: Towards pure electrospun PANI. AIP Conference Proceedings, 1459(1), 253–255. https://doi.org/10.1063/1.4738460

FFES - Process Parameters

Polymer precursor: PANI doped with Dodecyl Benzene Sulfonic Acid to produce PANI-DBSA
Solvent: Chloroform with different PEO to PANI-DBSA concentrations
Deposition temperature: 21 °C
Deposition rate: 707 µl/h
Needle-to-collector distance: 12 cm
Electrospinning variation: rotating drum as collector

high magnification



low magnification

PANI:PEO 1:1 w/w	PANI:PEO 1:0.8 w/w	PANI:PEO 1:0.2 w/w	PANI:PEO 1:0.1 w/w
Fiber diam: 597nm	Fiber diam: 306nm	Fiber diam: 259nm	Fiber diam: 240

Frontera, P., Busacca, C., Antonucci, P., Faro, M. Lo, Falletta, E., Pina, C. Della, & Rossi, M. (2012). Polyaniline nanofibers: Towards pure electrospun PANI. AIP Conference Proceedings, 1459(1), 253–255. https://doi.org/10.1063/1.4738460


Q&A

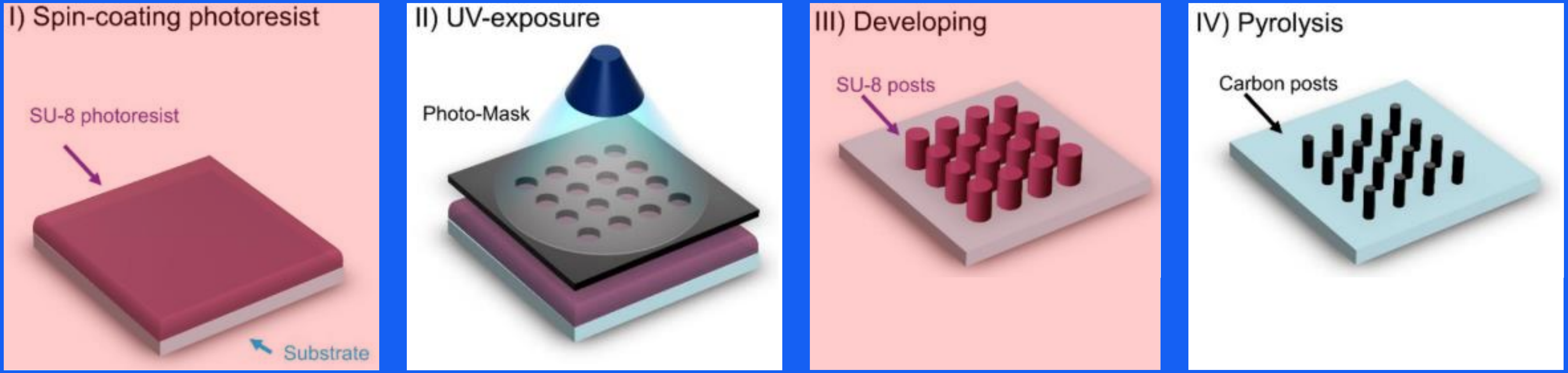
References

1. Cárdenas, B. (2017). Advanced Manufacturing Techniques for the Fabrication and Surface Modification of Carbon Nanowires, 160.
2. Flores, D. R. (2017). Role of rheological properties in near field electrospun fibers morphology, 130.

Previous work

The production of C-MEMS:

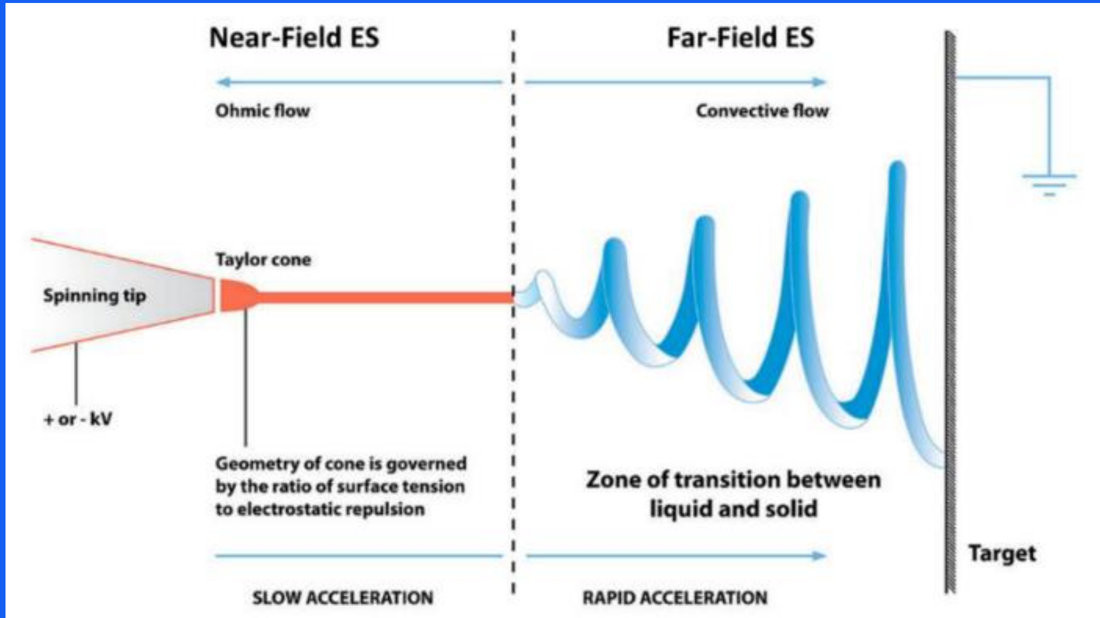
1. Polymer patterning through ~~photolithography~~ electrospinning
2. Carbonization through pyrolysis

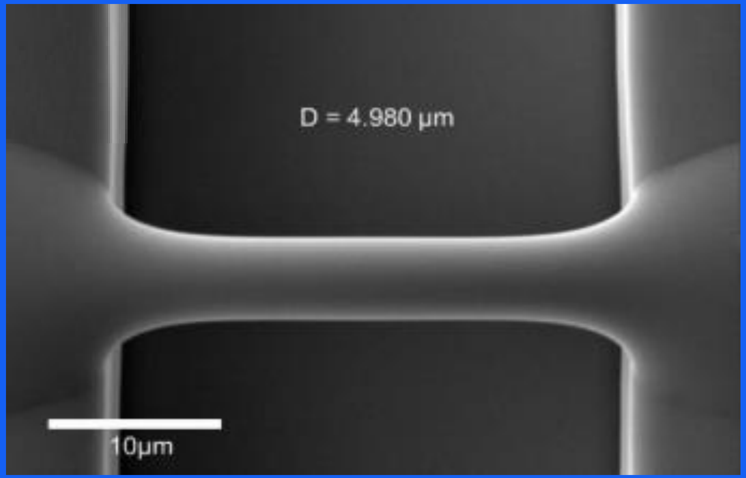


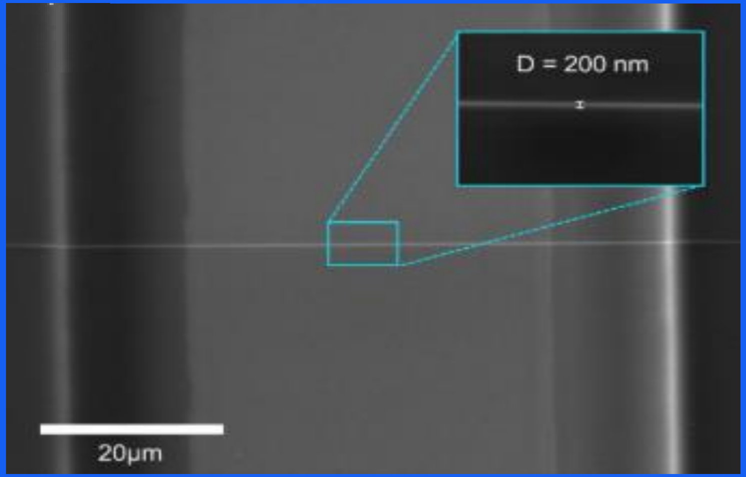
SU-8 waste

Best Results so far by Braulio & Ricardo

Fiber yield rate of 81 %
Fiber diameter before pyrolisis of 4.966 µm
Fiber diameter after pyrolisis of 204 nm
Fiber length of 60.5 ± 4.3 µm
Fiber resistance from 407 KΩ to 1.727 MΩ



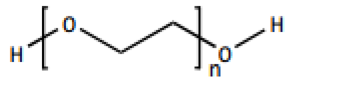




Polymer Solutions

wt% PEO	SU-8 2002 [mg]	PEO [mg]	TBT [mg]
0.25	2246	5.65	11.32

= 2 ml of solution


Poly(ethylene oxide) (PEO)

With zero shear viscosity of 0.88 Pa.s electrospun at 600V (solution used to get the results of the previous slide)

Next step -> Discover a new polymer solution to beat Braulio's record …

wt% PEO Solution

The EMS polymer solution consisted of
2ml of SU-8 2002 mixed with
0.5 wt% of Poly(ethylene oxide) (PEO, 4,000,000 MW; SigmaAldrich Inc., Cat. N. 189464) and
0.5 wt% Tetrabutylammonium Tetrafluoroborate salts (TBATFB; SigmaAldrich Inc., Cat. N. 217964) to increase its conductivity and allow smooth polymer flow during electrospinning.

All reagents were used as received. Magnetic stirring of these components was performed for 1hr at 75°C and low rpm (100-150 rpm).

MICROCHEM CORP SU-8 2002 500ML

encompass

Manufacturer: MICROCHEM CORP Y111029

Catalog No.	NC0702370
$628.71 / Each	
Qty	Check Availability
Add to cart	

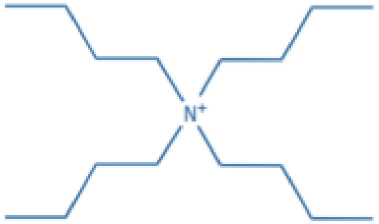
https://www.fishersci.com/shop/products/NC0702370/nc0702370#?keyword=MICROCHEM+CORP+PHOTORESIST+SU-8

MICROCHEM CORP SU-8 DEVELOPER 4L

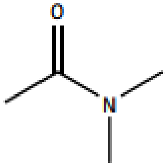
encompass

Catalog No.	NC9901158
$172.90 / Each	
Qty	Check Availability
Add to cart	

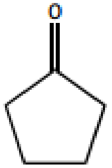
https://www.fishersci.com/shop/products/NC9901158/nc9901158#?keyword=SU-8++developer



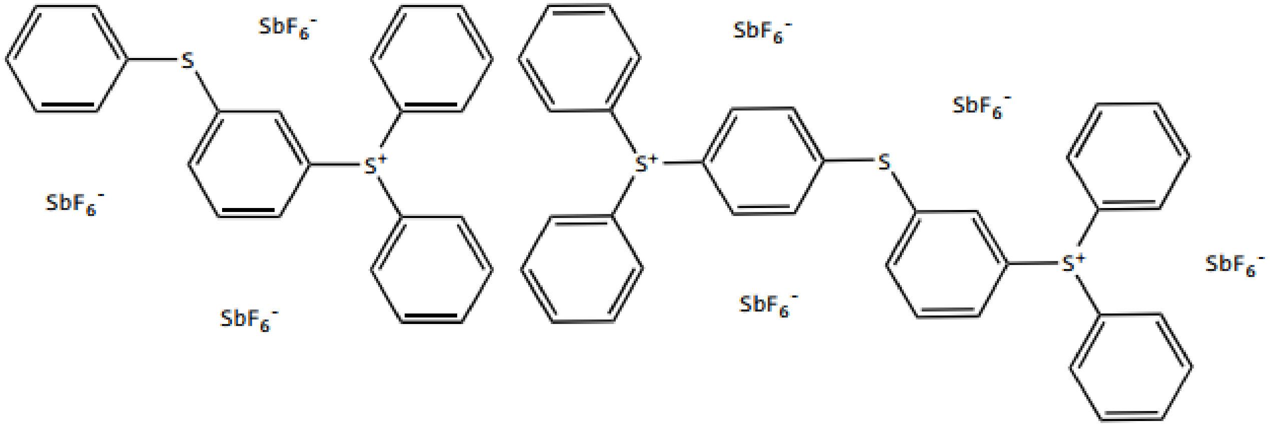
Tetrabutylammonium tetrafluoroborate (TBF)



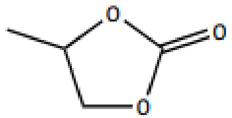
N,N Dimethylformamide (DMF)



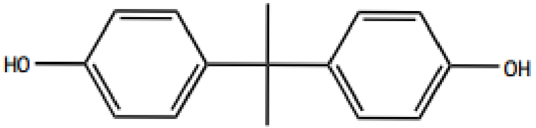
Cyclopentanone (CAS: 120-92-3)



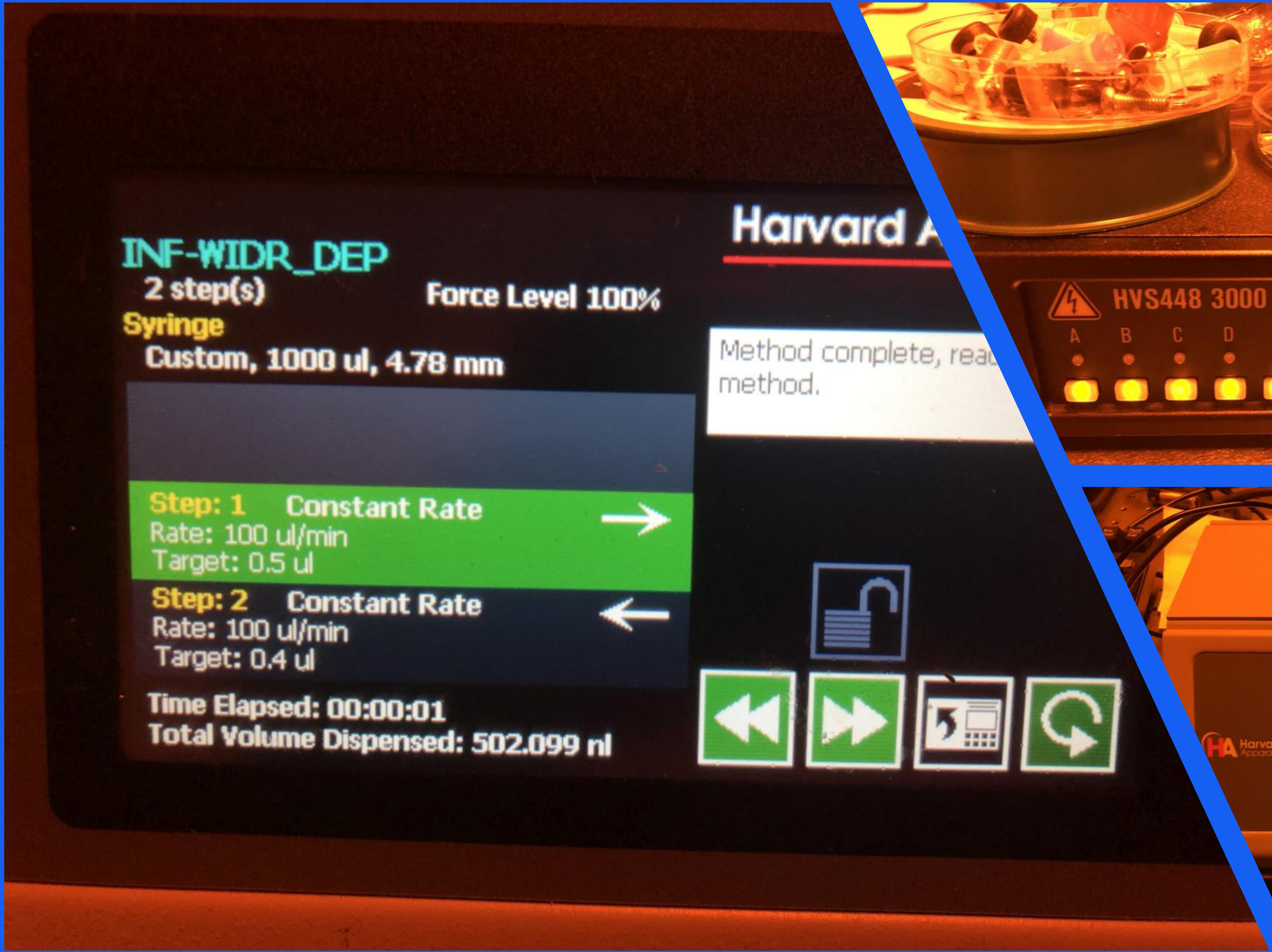
Mixed Triarylsulfonium/Hexafluoroantimonate Salt (CAS: 89452-37-9)/(CAS: 71449-78-0)



Propylene Carbonate (CAS: 108-32-7)

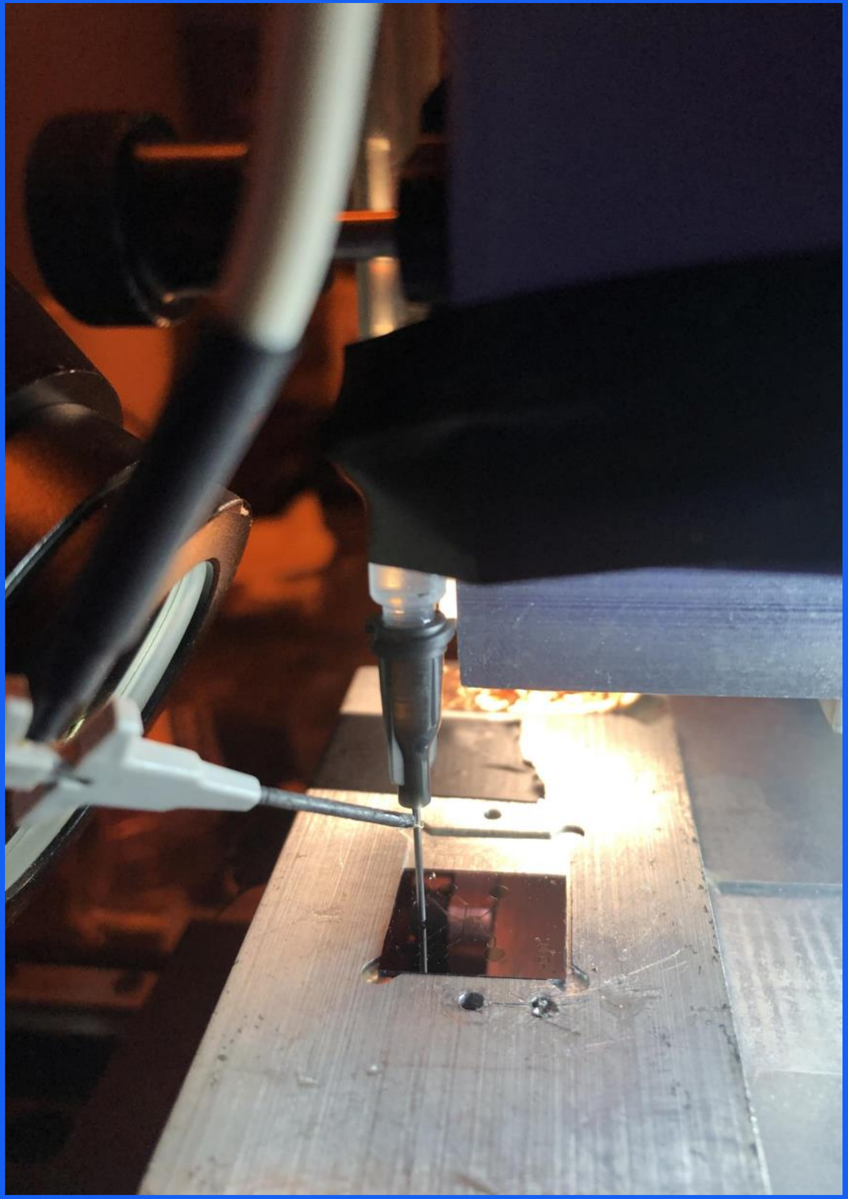


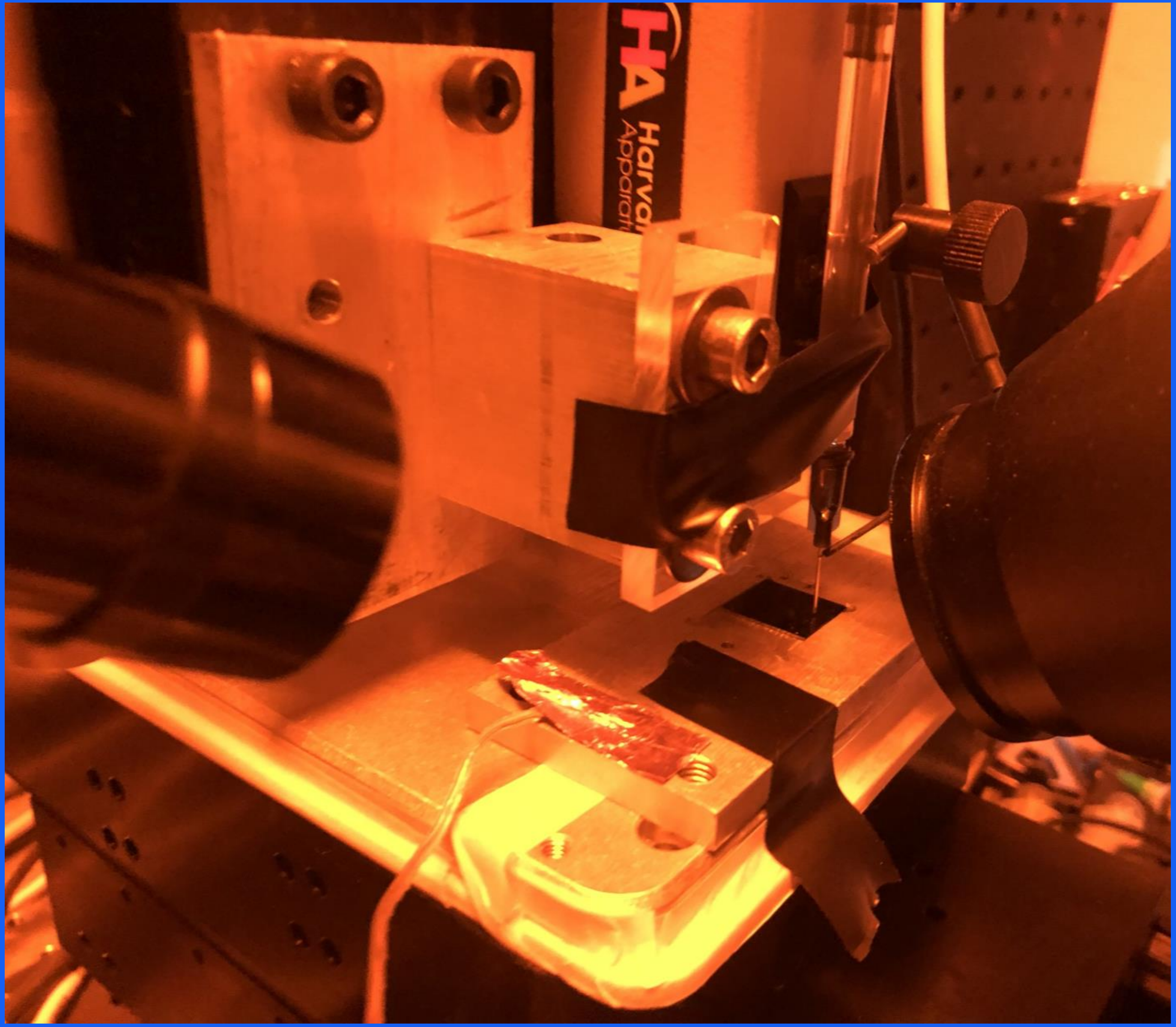
Epoxy Resin (CAS: 28906-96-9)
2-(Chloromethyl)oxirane; formaldehyde; 4-[2-(4-hydroxyphenyl)propan-2-yl]phenol

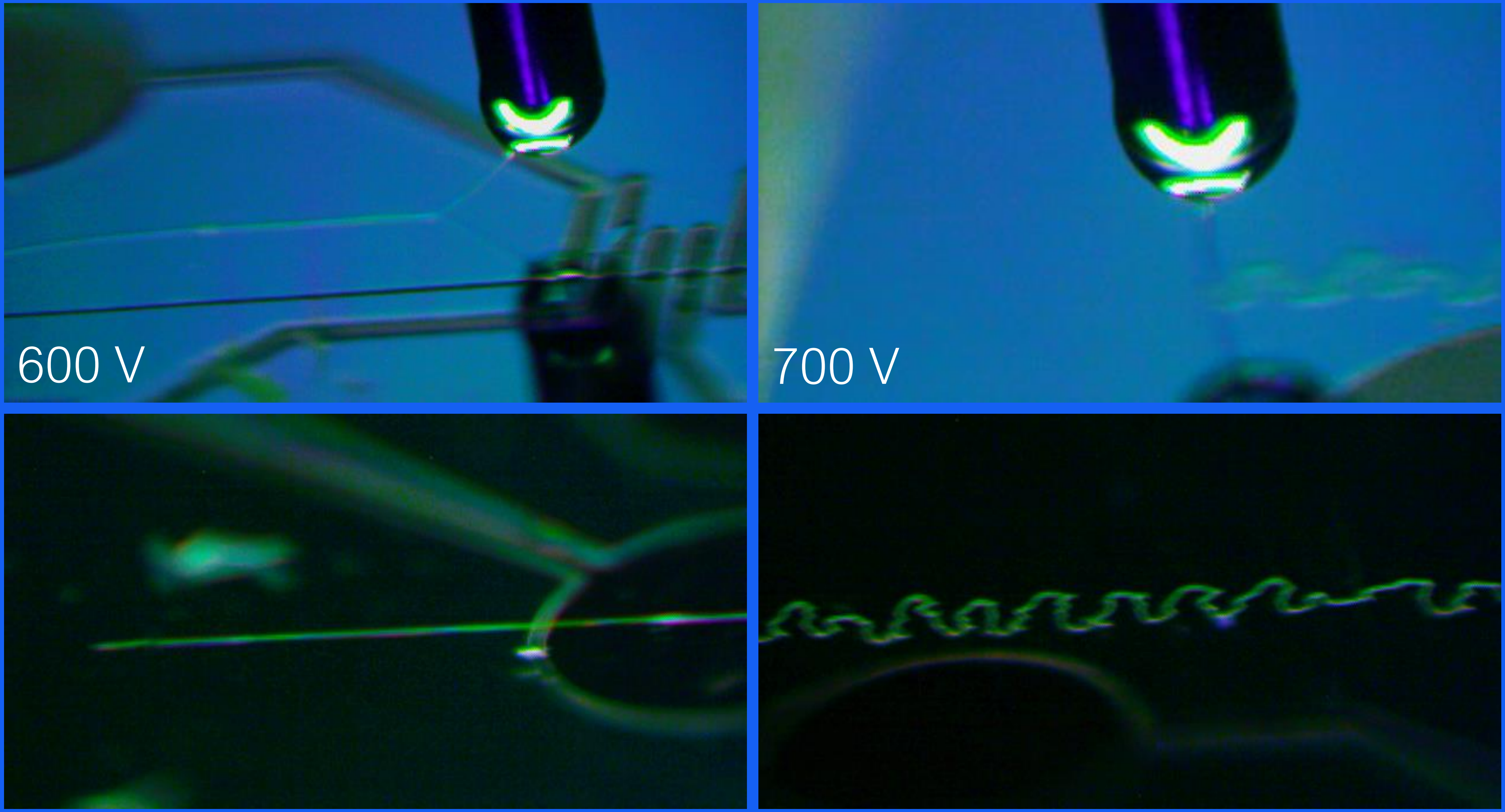

INF-WIDR_DEP
2 step(s)
Force Level 100%
Syringe
Custom, 1000 ul, 4.78 mm
Harvard A
Method complete, rea
method.
Step: 1 Constant Rate
Rate: 100 ul/min
Target: 0.5 ul
Step: 2 Constant Rate
Rate: 100 ul/min
Target: 0.4 ul
Time Elapsed: 00:00:01
Total Volume Dispensed: 502.099 nl

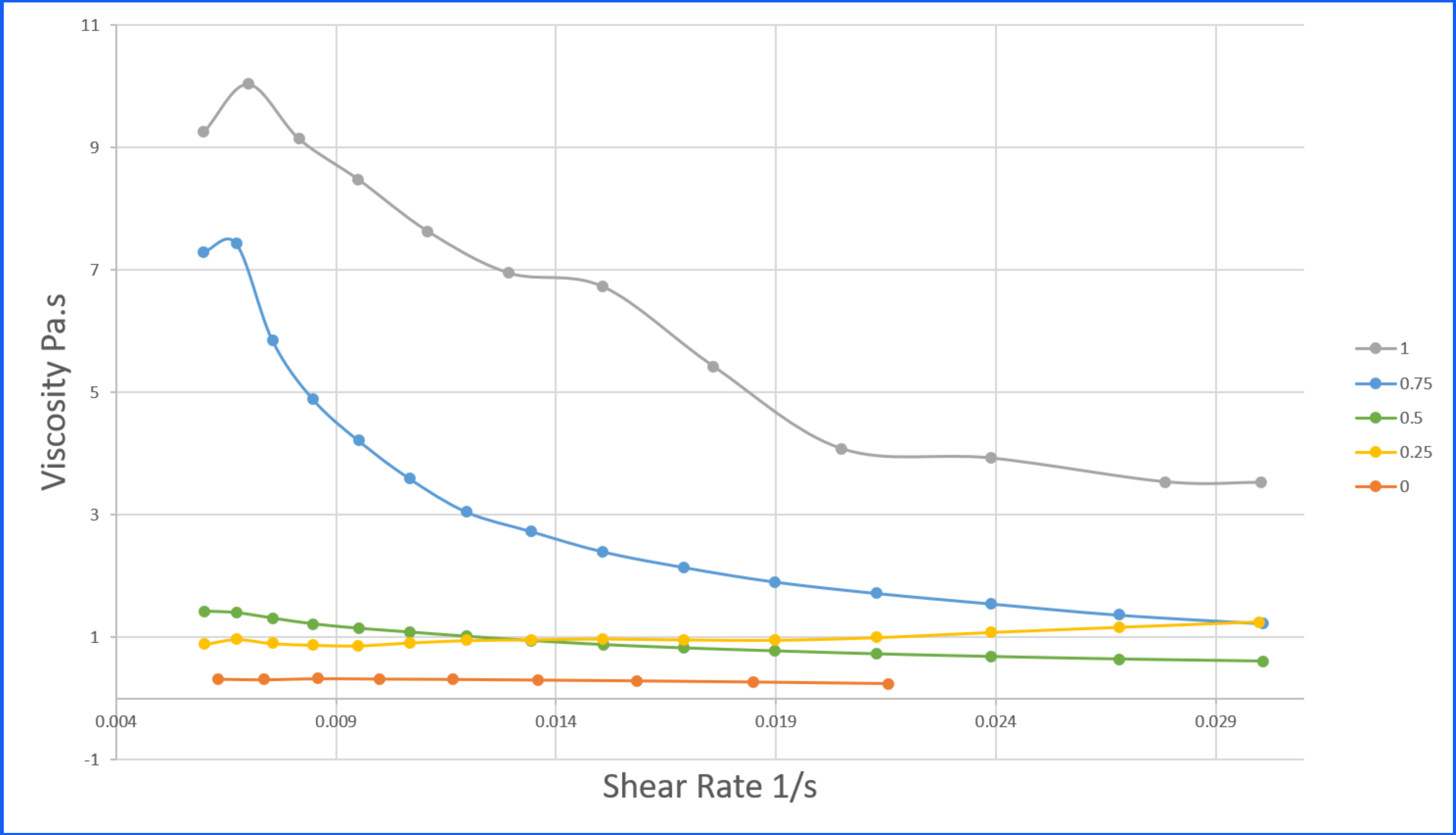

HVS448 3000 V High Voltage Sequencer
ENABLE
DISABLE
TRIGGER
PAUSE
RUN
STOP
A
B
C
D
E
F
G
H
ALL


HA Harvard Apparatus
Harvard Apparatus
Pump 11 Elite




HA


600 V
700 V



11
9
7
5
3
1
-1
Viscosity Pa.s
0.004
0.009
0.014
0.019
0.024
0.029
Shear Rate 1/s
1
0.75
0.5
0.25
0

Safety	Solvents	CAS Number	Presentation
	1-Methyl-2-pyrrolidinone (NMP)	872-50-4	anhydrous, 99.5% 328634-100ML 328634-1L
	Dichloromethane (Methylene chloride)	75-09-2	anhydrous, ≥99.8%, 40-150 ppm amylene as stabilizer 270997-100ML 270997-1L
	Dimethylacetamide (DMAc)	127-19-5	anhydrous, 99.8% 271012-100ML 271012-1L
250 ml	Dimethylformamide (DMF)	68-12-2	anhydrous, 99.8% 227056-100ML 227056-1L
1 L	Tetrahydrofuran (THF)	109-99-9	anhydrous, ≥99.9%, inhibitor-free 401757-1L
	Dihydrolevoglucosenone (Cyrene)	53716-82-8	807796-100ML 807796-1L
	Polymers		
	Polystyrene (PS)	9003-53-6	average Mw 192,000 430102-1KG
	Poly(styrene-co-butadiene)	9003-55-8	butadiene 4 wt. %, melt index 6 g/10 min (200°C/5kg) 430072-1KG
	Poly(styrene-co-α-methylstyrene)	9011-11-4	457205-250G
	Polybenzimidazole (PBI)	26985-65-9	rod, diam. 9.5 mm, L 25 mm, black GF31259527-1EA
	Polyaniline (PANI / emeraldine salt)	25233-30-1	average Mw >15,000, powder (Infusible), 3-100 µm particle size 428329-5G
	Polyvinylcarbazole (PVK)	25067-59-8	average Mw ~1,100,000, powder, 182605-5G

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