



U.S. ARMY COMBAT CAPABILITIES DEVELOPMENT COMMAND ARMY RESEARCH LABORATORY

TEAH as a TMAH Alternative

2 OCT 2026

Itzayana Gutierrez

Distribution Statement A: Approved for
public release: distribution is unlimited.

WHY NOT TMAH?

- Highly toxic
 - Fatal on skin contact
 - Can cause cardiac arrest and brain damage
- Additional Safety Measures at ARL:
 - Process requires two people (user and buddy)
 - Both need to take specific 25% TMAH training
 - Both need to review the SOP and sign



Acute oral toxicity	Category 2
Acute dermal toxicity	Category 1
Skin Corrosion/Irritation	Category 1 B
Serious Eye Damage/Eye Irritation	Category 1
Specific target organ toxicity (single exposure)	Category 1
Target Organs - Central nervous system (CNS), Respiratory system.	
Specific target organ toxicity - (repeated exposure)	Category 1
Target Organs - Thymus.	

Label Elements

Signal Word

Danger

Hazard Statements

Causes severe skin burns and eye damage
 May cause respiratory irritation
 Causes damage to organs
 Causes damage to organs through prolonged or repeated exposure
 Fatal if swallowed or in contact with skin





A DEVELOPER BY ANY OTHER NAME

NovoSafe SE 44 and NovoSafe SE 44-26

TETRAETHYLAMMONIUM HYDROXIDE (TEAH)



- A Quaternary Ammonium Hydroxide similar to TMAH
- Sold by Transene as NovoSafe in various dilutions
- Still Hazardous
 - Temporarily desensitizes neuromuscular junction
 - Paralyzed frog muscles for 30 minutes
 - Test with TEAB caused paralysis in subject for 2 hours with no after effects
 - Fatal to subject with asthma
 - Still corrosive

GHS Classifications

H290 Corrosive to Metals: Category 1
H303 Acute toxicity Oral: Category 4
H314 Skin corrosion / Skin irritation: Category 1
H318 Serious eye damage / Eye irritation: Category 1
H371 Special target organ systemic toxicity single exposure: Category 1
H373 Special target organ systemic toxicity repeated exposure: Category 1

Pictograms or Hazard symbols



Signal Word: Danger

Causes severe skin burns and serious eye damage.

May be corrosive to metals

Causes damage to organs if swallowed.

Causes damage to organs through prolonged or repeated exposure in contact with skin

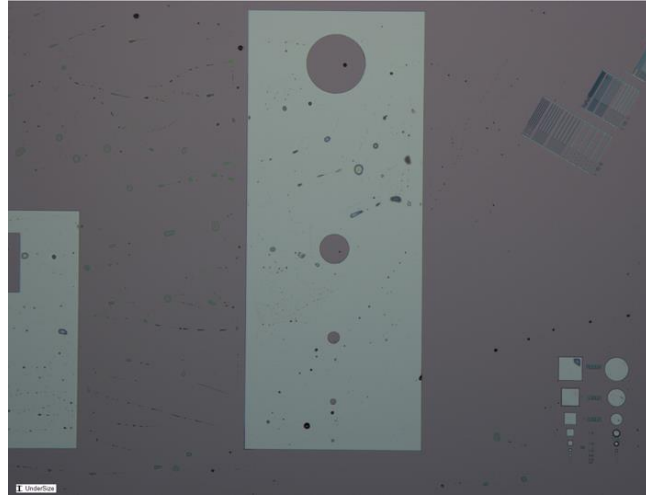
MIR 701 TEST



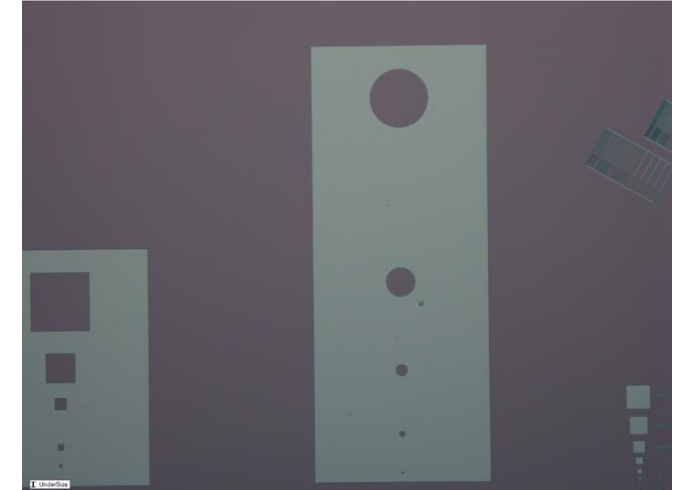
Process Details:

- Spun at 2k
- 212.4 mJ/cm² exposure
- 110C 90sec PEB
- 60 sec Beaker develop

SE 44-26

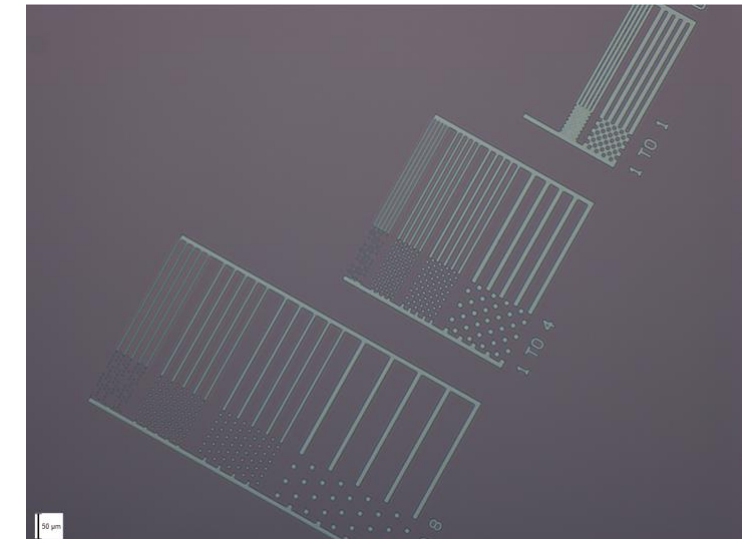
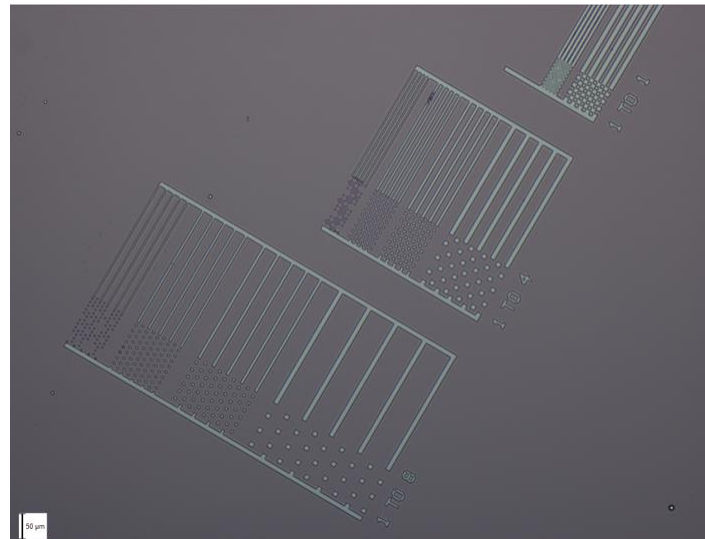


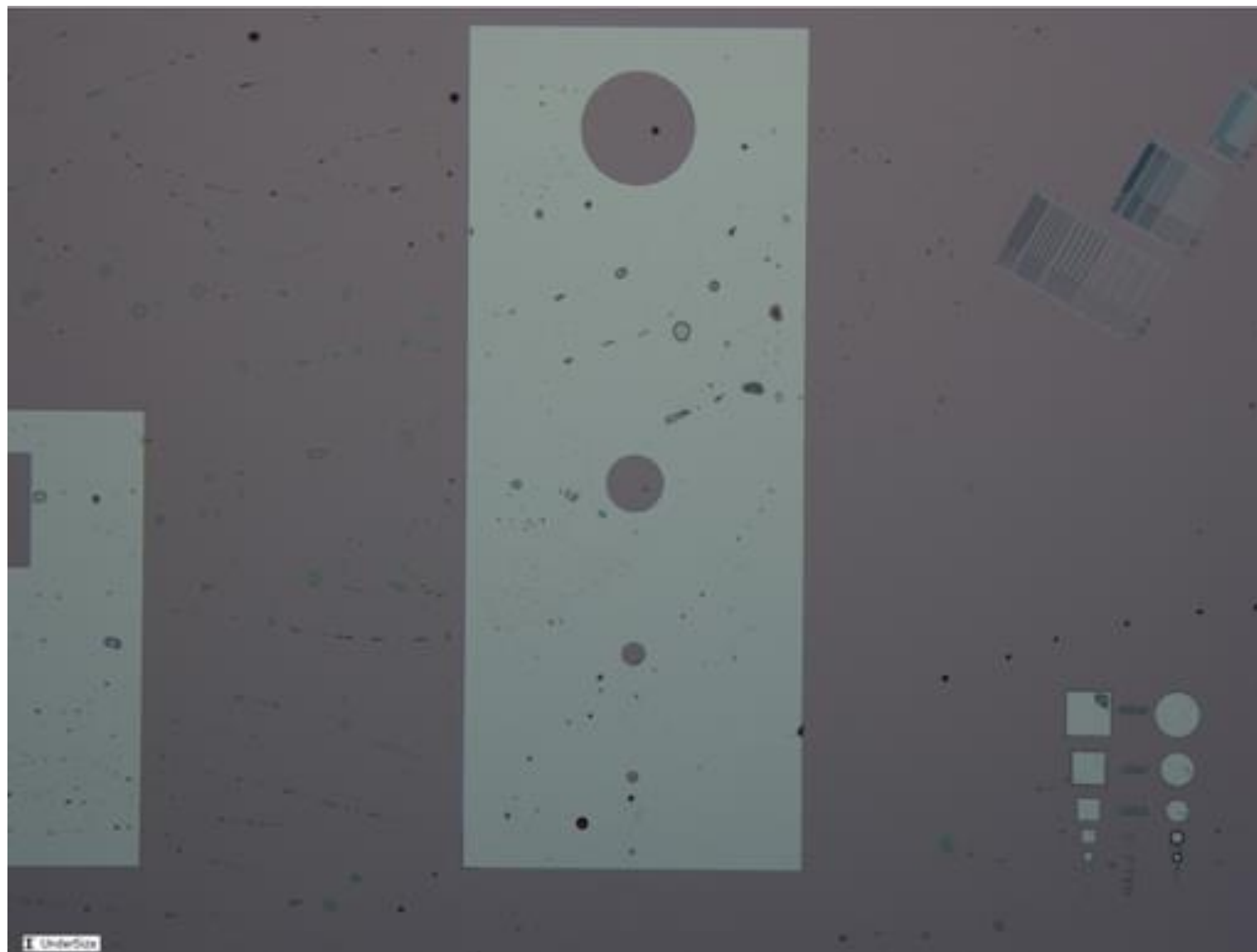
AZ 300 MiF

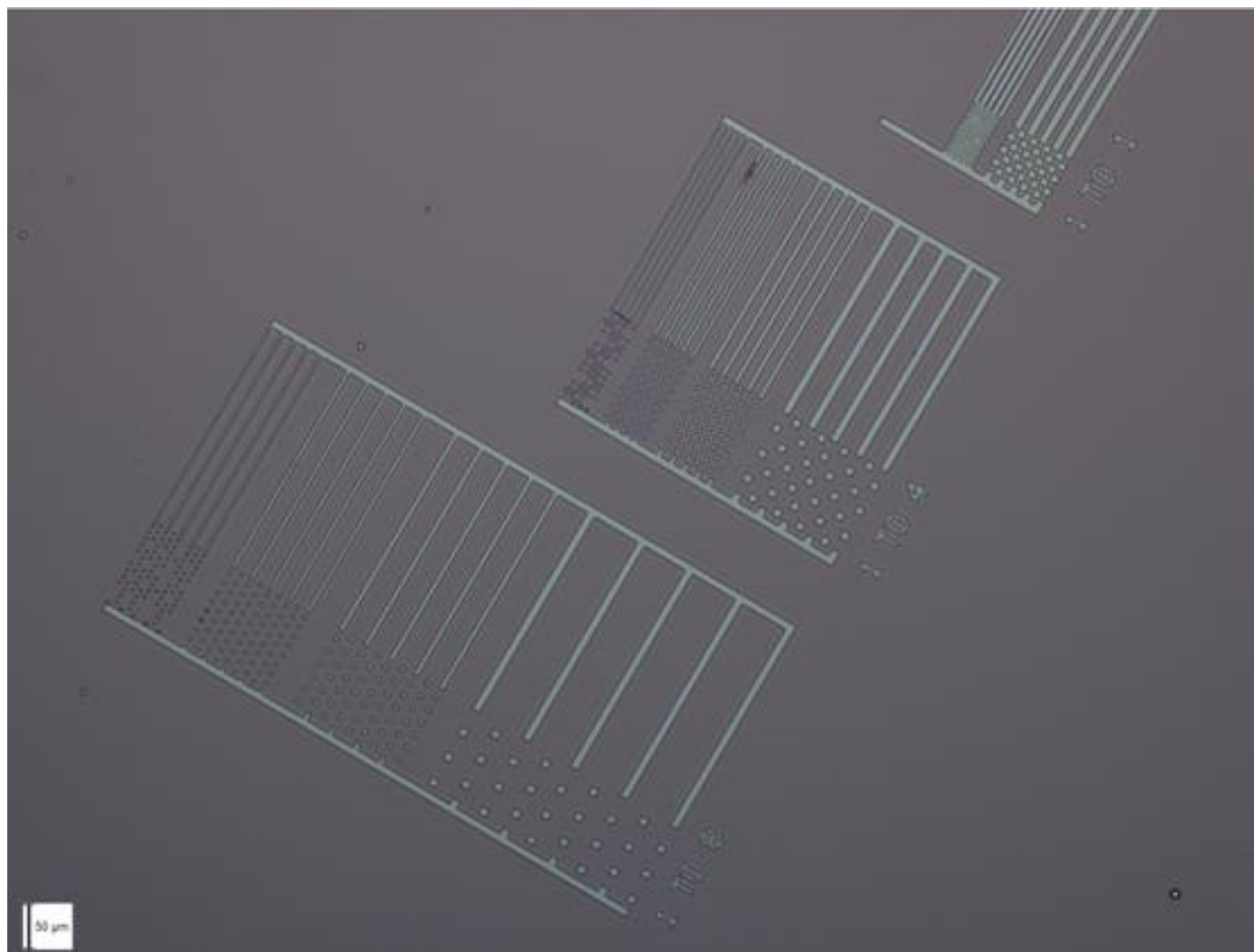


Results:

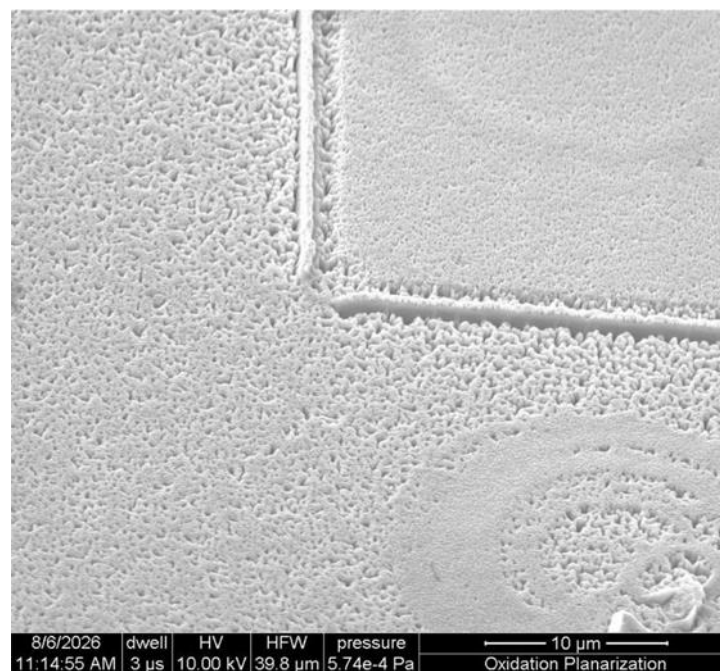
- Developed in SE 44-26
- Required 2.5x exposure compared to AZ 300
- Comparable results to AZ 300
- Note: AZ 5214 did not come out well. More work will be needed to be done







SILICON CLEAN IN SE 44-26



- 2 hour dip in 70°C SE44-26

SILICON ETCH TEST



	SE 44	TMAH
Starting Thickness	681 μm	680 μm
Temperature	70°C	70°C
Time	60 min	60 min
Ending Thickness	673 μm	662 μm
Etch Rate	0.15 $\mu\text{m}/\text{min}$	0.3 $\mu\text{m}/\text{min}$

- Etch rate for SE 44 was 50% the etch rate of 25% TMAH

COMPARISONS



TEAH	TMAH
- Slightly More Expensive: - SE 44: \$398/gal - SE 44-26: \$182/gal	- Less Expensive 25% TMAH: \$385/gal - AZ 300: \$114/gal
- Longer Processing Times: 2.5x exposure time needed for development 40% of the etch rate of 25% TMAH	Shorter process times, and more data available for processes
Much less dangerous	Significantly higher risk
Fewer safety needs	More Safety Needs

SOURCES



- Tetramethylammonium hydroxide, 25% in water; CAS RN: 7732-18-5, 75-59-2; AC420520000; Ver 14; Fisher Scientific Company: Fair Lawn, Nj, 2025-Dec-19.
<https://www.fishersci.com/store/msds?partNumber=AC420520010&countryCode=US&language=en> (accessed 2026-Sep-29).
- NOVO Safe SE44; CAS RN: 77-98-5, 7732-18-5; Rev 1; Transene Company, Inc: Danvers, MA, 2025-Mar.
- Chun Chi Lin; Yang, C.; Ger, J.; Jou Fang Deng; Hung, D.-Z. Tetramethylammonium Hydroxide Poisoning. Clinical Toxicology 2010, 48 (3), 213–217. <https://doi.org/10.3109/15563651003627777>.
- GRAHAM AJ. Toxic effects in animals and man after tetraethylammonium bromide. Br Med J. 1950 Aug 5;2(4674):321-2. doi: 10.1136/bmj.2.4674.321. PMID: 15434379; PMCID: PMC2038391.
- Parsons RL. Mechanism of neuromuscular blockade by tetraethylammonium. Am J Physiol. 1969 Apr;216(4):925-31. doi: 10.1152/ajplegacy.1969.216.4.925. PMID: 4304760.



THANK YOU.

This presentation used images from Dr Ryan Greening and data from Dr Audrey Rose Gutierrez at Army Research Lab

Contact me at itzayana.gutierrez.ctr@army.mil

