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# Electrochemical Alloy Formation for Mercury Decontamination of Aqueous Solutions

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# Mercury in Aqueous Solutions

												13 IIIA 3A	14 IVA 4A	15 VA 5A	16 VIA 6A	17 VIIA 7A	18 VIIIA 8A			
2 IIA 2A												5 B Boron 10.811	6 C Carbon 12.011	7 N Nitrogen 14.007	8 O Oxygen 15.999	9 F Fluorine 18.998	10 Ne Neon 20.180			
4 Be Beryllium 9.012											11 IB 1B	12 IIB 2B	13 Al Aluminum 26.982	14 Si Silicon 28.086	15 P Phosphorus 30.974	16 S Sulfur 32.066	17 Cl Chlorine 35.453	18 Ar Argon 39.948		
12 Mg Magnesium 24.305											28 Ni Nickel 58.693	29 Cu Copper 63.546	30 Zn Zinc 65.38	31 Ga Gallium 69.723	32 Ge Germanium 72.631	33 As Arsenic 74.922	34 Se Selenium 78.971	35 Br Bromine 79.904	36 Kr Krypton 84.798	
20 Ca Calcium 40.078	21 Sc Scandium 44.956											46 Pd Palladium 106.42	47 Ag Silver 107.868	48 Cd Cadmium 112.414	49 In Indium 114.818	50 Sn Tin 118.710	51 Sb Antimony 121.760	52 Te Tellurium 127.6	53 I Iodine 126.904	54 Xe Xenon 131.294
38 Sr Strontium 87.62	39 Y Yttrium 88.906											78 Pt Platinum 195.085	79 Au Gold 196.967	80 Hg Mercury 200.592	81 Tl Thallium 204.383	82 Pb Lead 207.2	83 Bi Bismuth 208.980	84 Po Polonium [209]	85 At Astatine 209	86 Rn Radon 222.018
56 Ba Barium 137.328	57 La Lanthanum 138.905											110 Ds Darmstadtium [285]	111 Rg Roentgenium [272]	112 Cn Copernicium [277]	113 Uut Ununtrium unknown	114 Fl Flerovium [289]	115 Uup Ununpentium unknown	116 Lv Livermorium [293]	117 Uus Ununseptium unknown	118 Uuo Ununoctium unknown
88 Ra Radium 226.025											110 Ds Darmstadtium [285]	111 Rg Roentgenium [272]	112 Cn Copernicium [277]	113 Uut Ununtrium unknown	114 Fl Flerovium [289]	115 Uup Ununpentium unknown	116 Lv Livermorium [293]	117 Uus Ununseptium unknown	118 Uuo Ununoctium unknown	

Natural waters

Industrial/commercial waste streams

Mining byproducts - Acids



Lanthanide Series

Actinide Series

Hg content

Volume

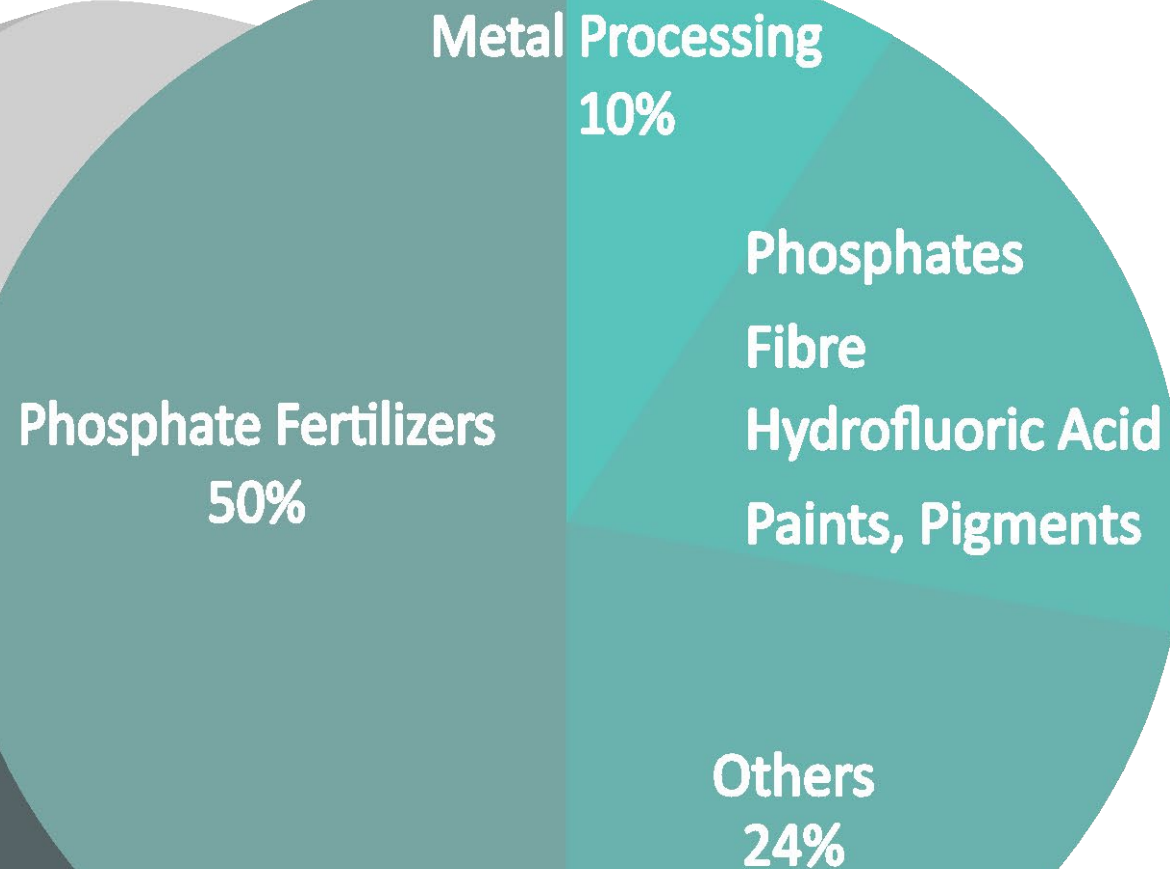
pH

u 94	64 Gd Gadolinium 157.25	65 Tb Terbium 158.925	66 Dy Dysprosium 162.500	67 Ho Holmium 164.930	68 Er Erbium 167.259	69 Tm Thulium 168.934	70 Yb Ytterbium 173.055	71 Lu Lutetium 174.967
m	96 Cm Curium	97 Bk Berkelium	98 Cf Californium	99 Es Einsteinium	100 Fm Fermium	101 Md Mendelevium	102 No Nobelium	103 Lr Lawrencium



# Concentrated Sulfuric Acid

Annual Production - 200 million tonnes



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Annual Production - 200 million tonnes

Mercury contamination in the smelting industry

Phosphate Fertiliser  
50%

**Technical Quality**

**0.30 mg/kg**

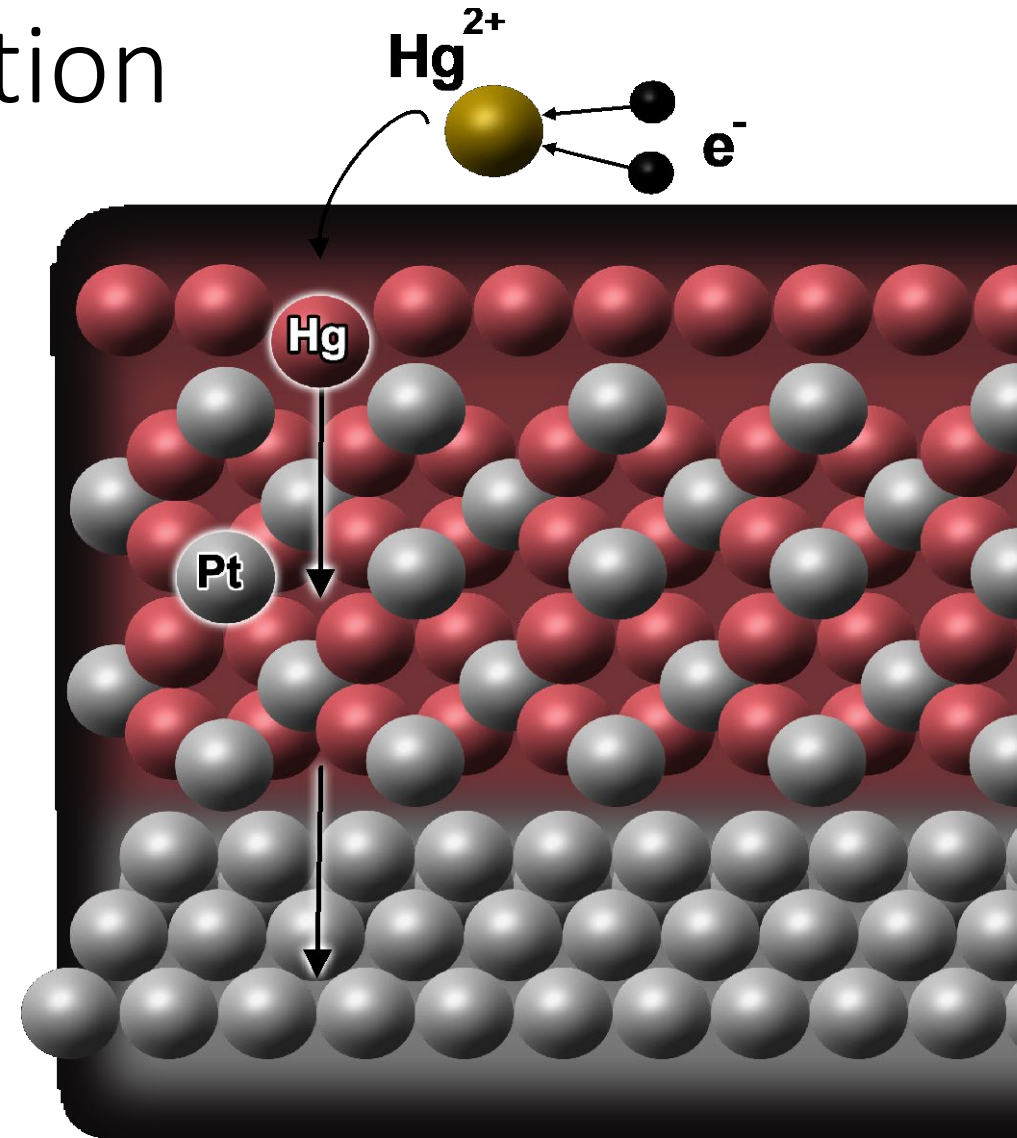
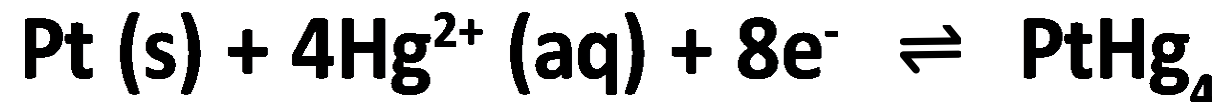
**High Purity**

**0.08 mg/kg**

No commercial removal method  
for produced acid



# Electrochemical Alloy Formation



## References

- Tunsu, C., Nat Commun. 9, 4876 (2018)
- Feldt, E., Sep. Purif. Techn. 319, 124033 (2023)
- Roth, V., ACS EST Engg. 3, 6, 823-830 (2023)



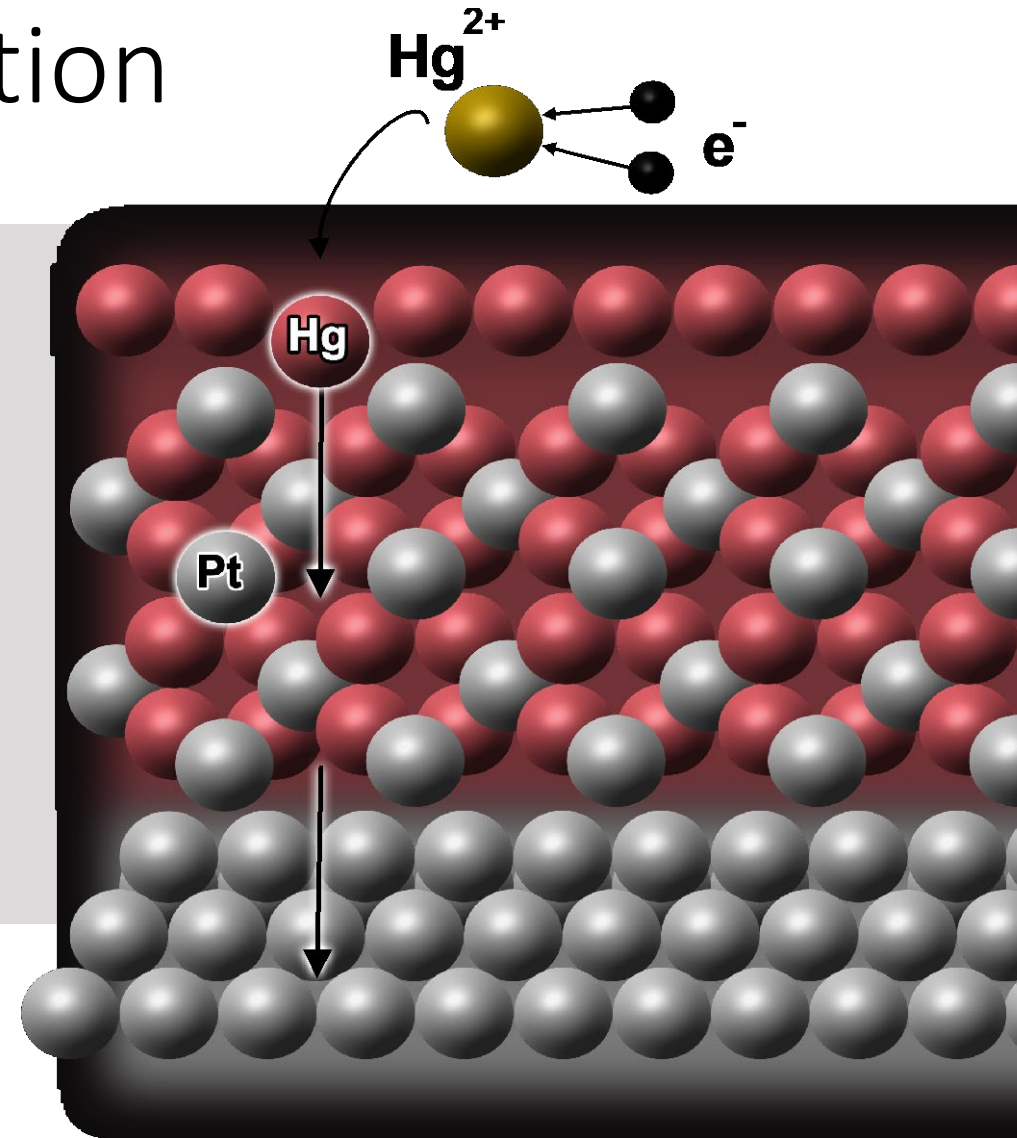
# Electrochemical Alloy Formation

Selectively removing > 99% Hg

Reversible

Unaffected by pH 0 – 6.6

Initial Hg concentrations 0.25 – 75,000  $\mu\text{g/L}$



## References

Tunsu, C., Nat Commun. 9, 4876 (2018)

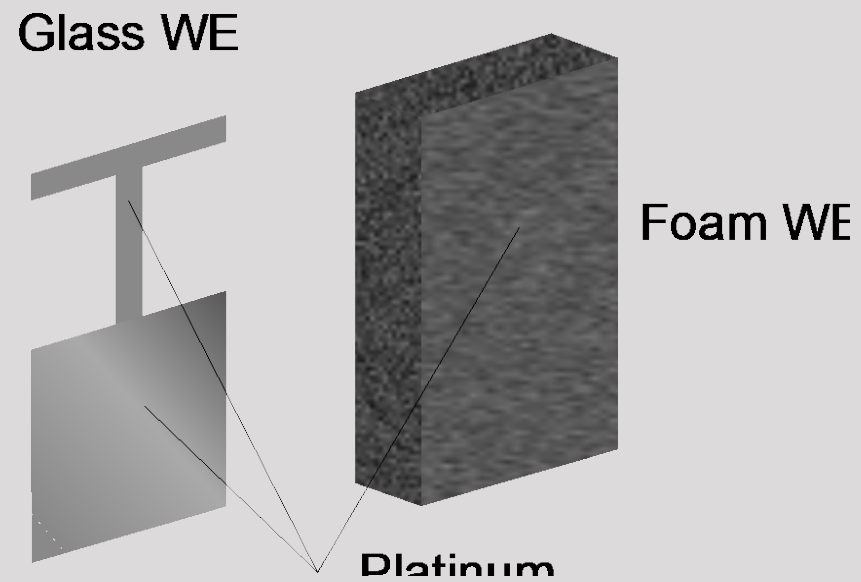
Feldt, E., Sep. Purif. Techn. 319, 124033 (2023)

Roth, V., ACS EST Engg. 3, 6, 823-830 (2023)



# Experimental

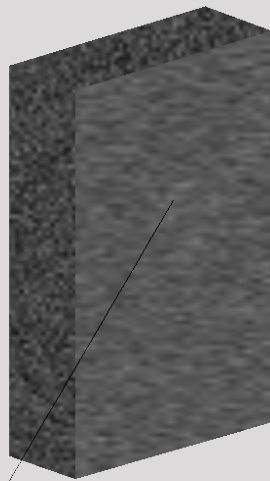
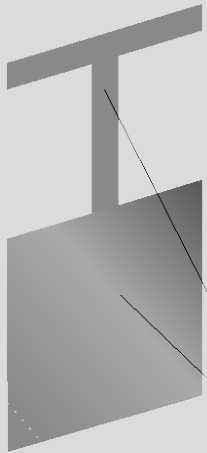
Mercury removal using electrochemical alloy formation



# Experimental

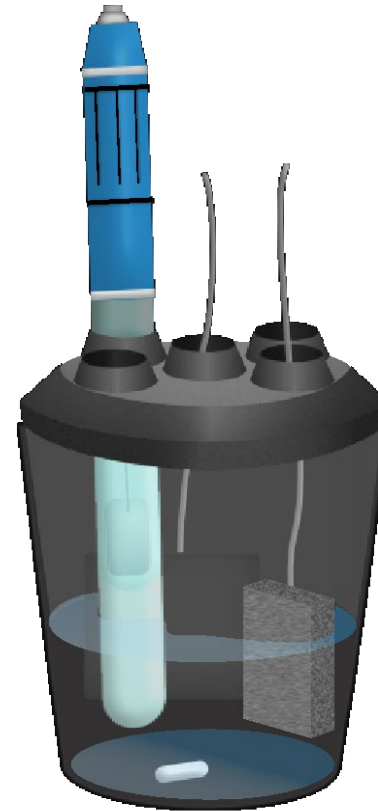
Mercury removal using electrochemical alloy formation

Glass WE



Platinum

Foam WE



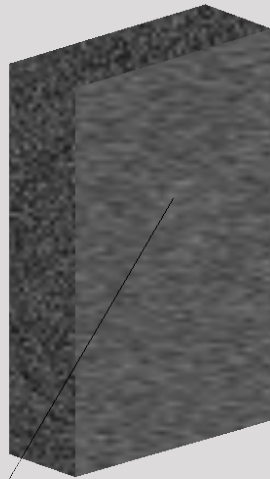
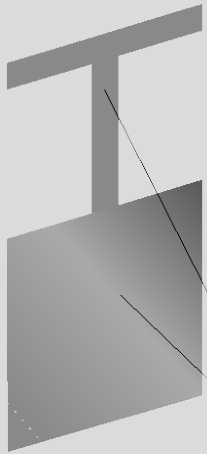
50 mL



# Experimental

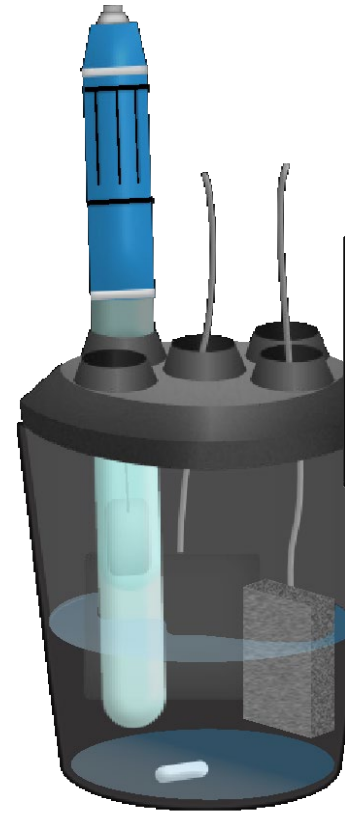
Mercury removal using electrochemical alloy formation

Glass WE

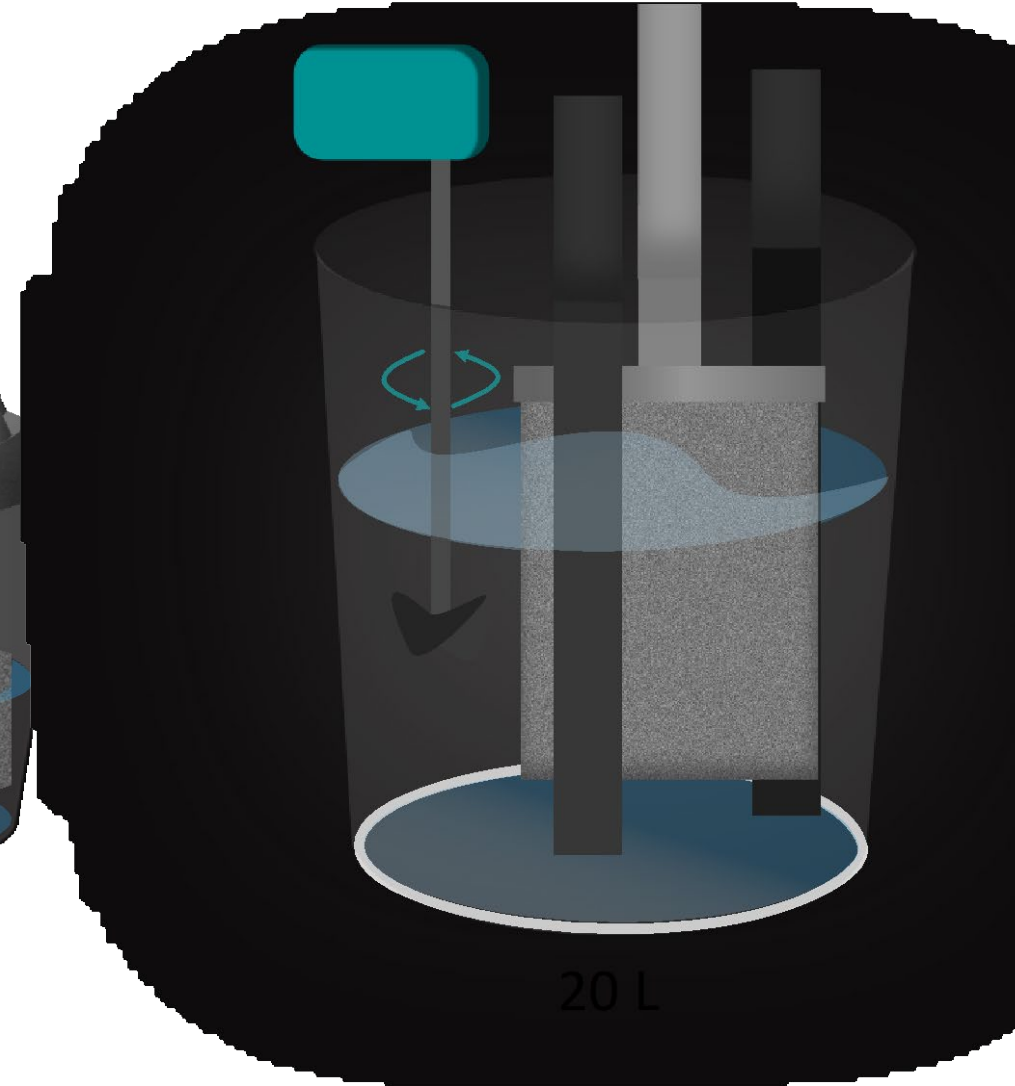


Platinum

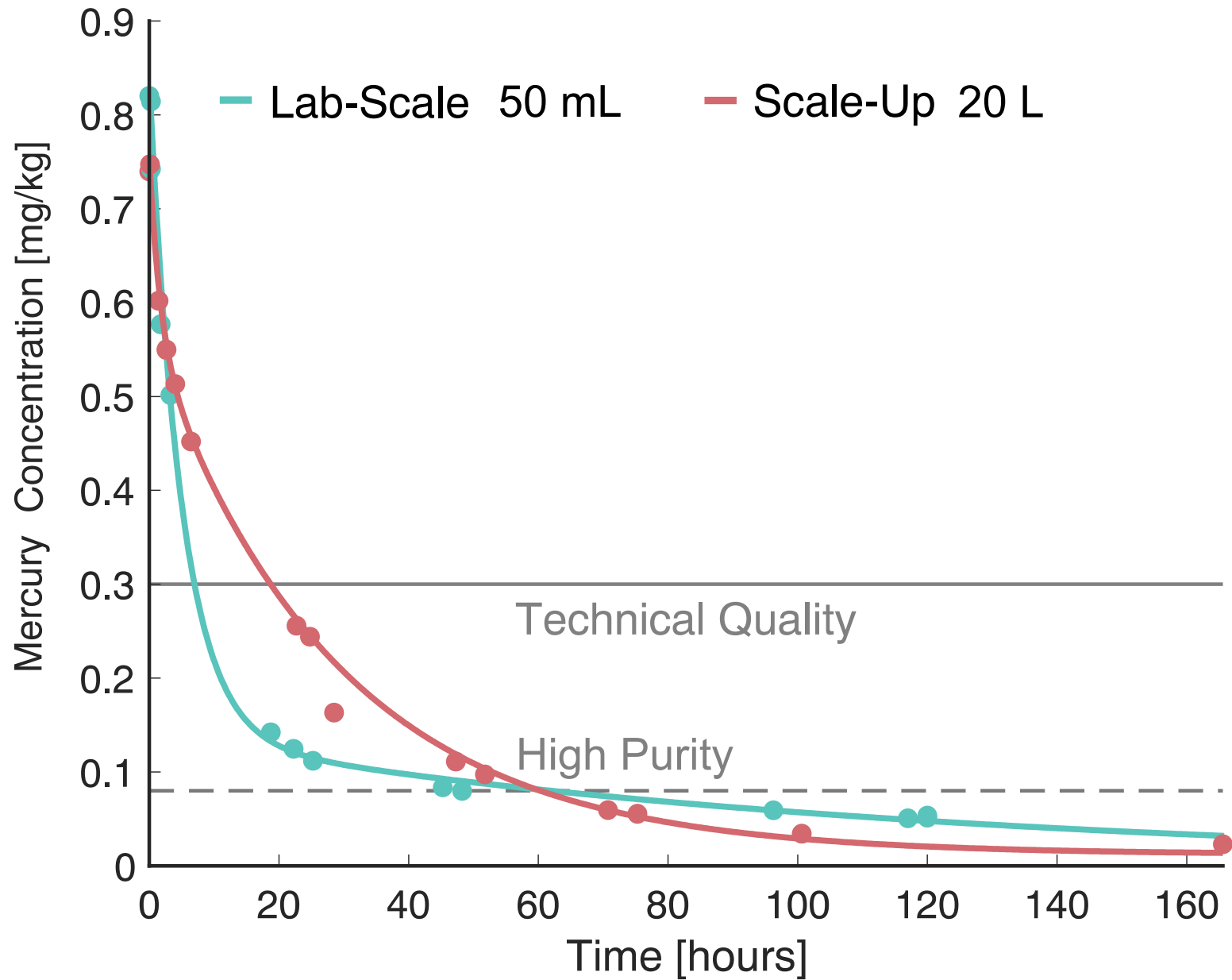
Foam WE



50 mL



20 L

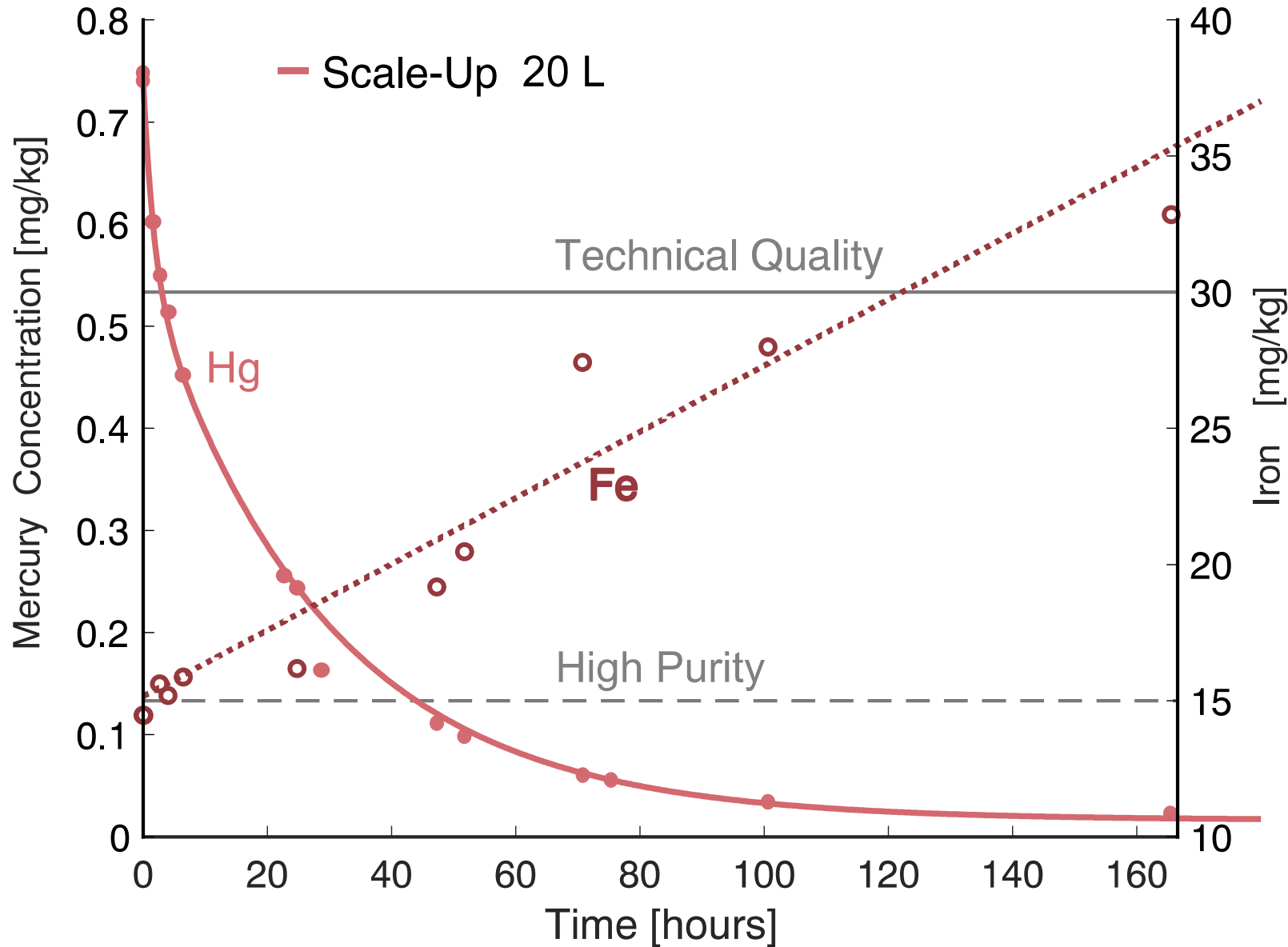


# Results

Conc. sulfuric acid

Pt on SS316L Foam





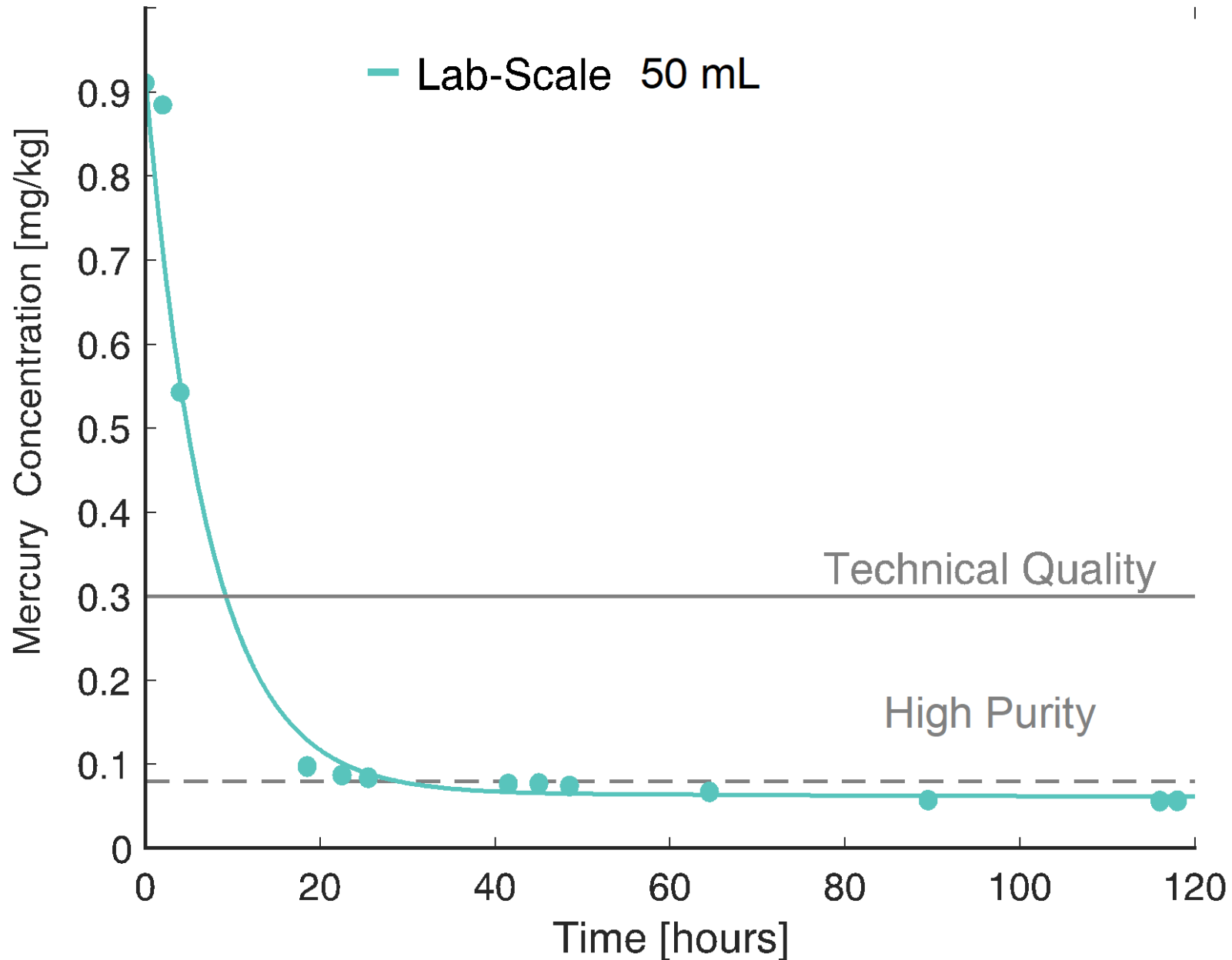
# Results

## Stability

Conc. sulfuric acid

Pt on SS316L Foam





# Results

Conc. sulfuric acid

Pt on Carbon (RVC) Foam





# Conclusion and Moving Forward



**Electrochemical alloy formation as a mercury removal method**

**Potential for concentrated acid decontamination**

Conc. sulfuric acid from smelting – 98% [Hg] removed in 20 L

Technical quality / High purity (0.30 / 0.08 mg/kg) < 80 hours



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**Scale up and flow reactor**



**Optimize regeneration**



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**Main Challenges - Stability**



# Acknowledgements

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