CASE STUDY
#CS_SM008-0

SiliCycle

SiliaMetS®

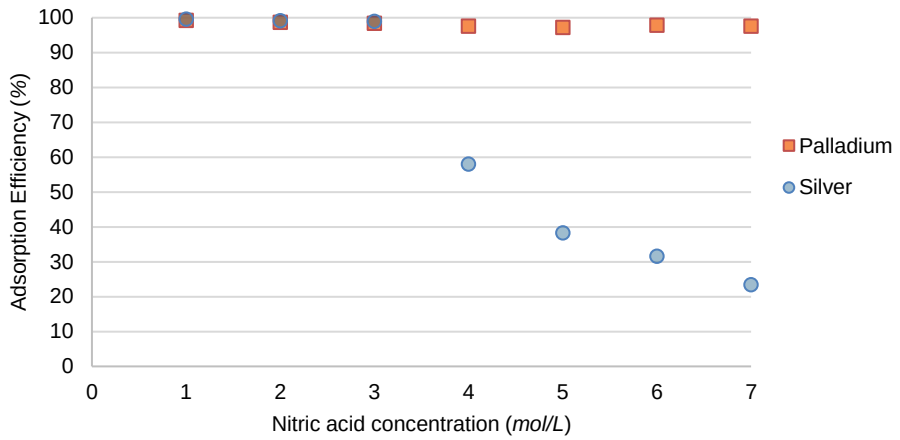
Separation of Palladium and Silver from E-Waste Leachate Using SiliaMetS Thiol

Electronic waste (*e-waste*) is the collection of used devices including cell phones, TVs, monitors, tablets and other unwanted consumer gadgets often destined for landfill. These devices tend to contain many precious metals (*copper, gold, silver, palladium…)* especially within the circuit boards found within. There is a growing demand for proper disposal in order to extract these metals for reuse and reduce mining operations. This Case Study details the extraction of palladium and silver from circuit boards using Silia*MetS* Thiol prior to a subsequent recycling step.

LEARN MORE about Silia*MetS* in our brochure "*Solutions for Scavenging of Metal & Organic Impurities*".

Aiming to implement a circular economy of precious metals, Väisänen's group experimented with recycling metals, namely palladium and silver, from printed circuit boards found in electronics. The team used Silia*MetS* Thiol to scavenge both palladium and silver ions from e-waste leachate at various nitric acid concentrations with the goal of separating the two metals for further recycling. Nitric acid was selected to pre-treat the electronic circuit boards due to its poor selectivity to other precious metals such as platinum and gold.

Figure 1: Palladium and silver adsorption at increasing nitric acid concentrations



As seen in Figure 1, the adsorption efficiency of palladium remained constant over the range of concentrations tested while the adsorption of silver dramatically decreased in efficiency at concentrations over 3 mol/L.

The procedure for adsorption involved 50 mg of Silia*MetS* Thiol Scavenger per 7.5 or 10 mL of the nitric acid leachate sample. The mixture was stirred for two hours at room temperature, then filtered and rinsed with water.

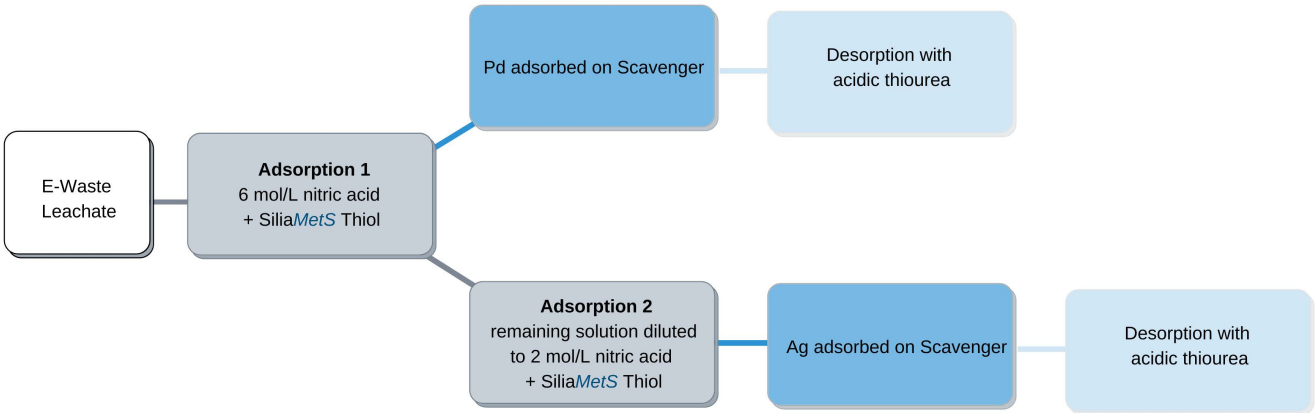
To recover and separate the metals, different desorption solutions were tested and are presented in Table 1. While basic thiosulfate was the most efficient to desorb the metals from the silica scavenger, the high pH can dissolve the functionalized silica which is not congruent with the aim of recycling the Scavenger. Acidic thiourea was the second-best option, allowing both metals to desorb fully. One thing to note was that it did not allow the separation of the metals from one another, meaning that a creative approach was needed.

For this reason, a selective two-step adsorption was suggested to separate the metal at the adsorption step instead of the desorption step. Namely, the palladium content was first adsorbed with a nitric acid concentration of 6 mol/L. A second, separate, adsorption step with a nitric acid concentration of 2 mol/L was pursued to adsorb silver ions. The two materials were then desorbed with 80 % efficiencies using acidic thiourea solutions, resulting in efficient adsorption-desorption and separation of the two metals. Traces of other adsorbed metal impurities (*copper or tin*) can be removed using diluted mineral acids before the desorption process.

Table 1: Desorption solutions and efficiencies

Desorption Solutions and Efficiencies		
	Ag Efficiency (%) *(with 2 mol/L adsorption)*	Pd Efficiency (%) *(with 6 mol/L adsorption)*
1 mol/L HCl	1.4	1.8
3 mol/L HCl	4.7	3.7
1 mol/L H_2SO_4	0.3	0.0
3 mol/L H_2SO_4	0.4	0.0
0.3 mol/L Thiourea	60.6	7.2
0.5 mol/L Thiourea	82.6	7.2
7 mol/L HNO_3	43.2	0.5
0.3 mol/L HCl + 0.3 mol/L Thiourea	101.8	47.4
0.3 mol/L HNO_3 + 0.3 mol/L Thiourea	**102.6**	**78.8**
0.3 mol/L NaOH + 0.3 mol/L Thiosulfate	107.6	87.5

Figure 2: Overview of the procedure for palladium and silver removal from e-waste



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