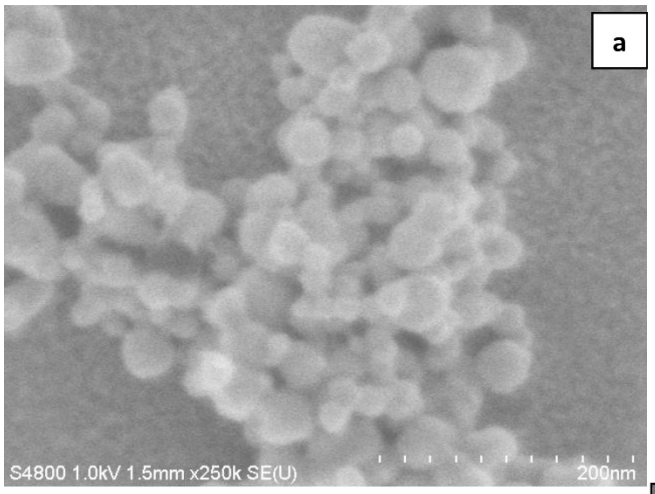
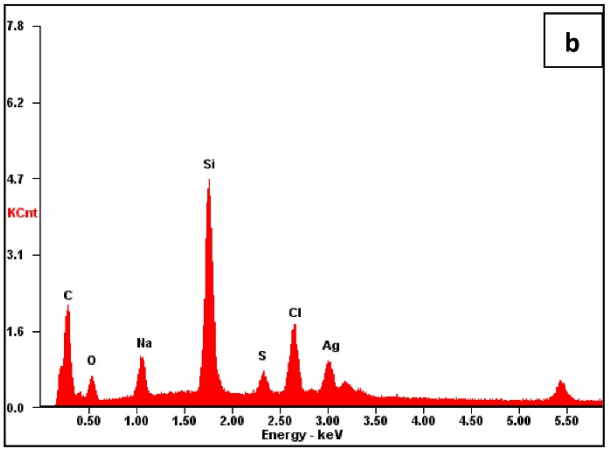




c

Element	*Wt%*	*At%*
CK	47.82	70.82
OK	06.63	07.37
NaK	03.83	02.97
SiK	17.21	10.90
SK	02.29	01.27
ClK	08.92	04.48
AgL	13.31	02.19
Matrix	Correction	ZAF

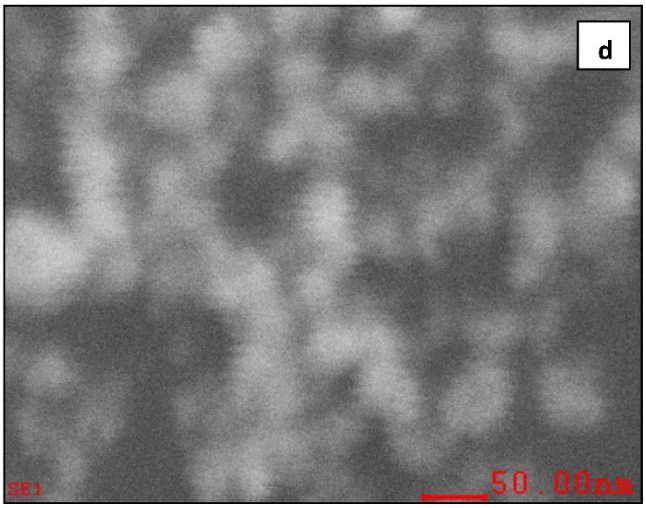


Figure S1 a: Electron microscopy of synthesized silver nanoparticles. Scanning electron microscopy (SEM) was used to image silver nanoparticles (AgCysNPs). Scale bar indicates 200 nm with individual gradations of 20 nm. Panels b-d: EDAX analysis of synthesized AgCysNPs, indicating the presence of sulfur (S) and silver (Ag) demonstrating the biohybrid nature of the material. Material was dried on a silicon wafer (Si), and synthesis included hydrochloric acid (Cl).

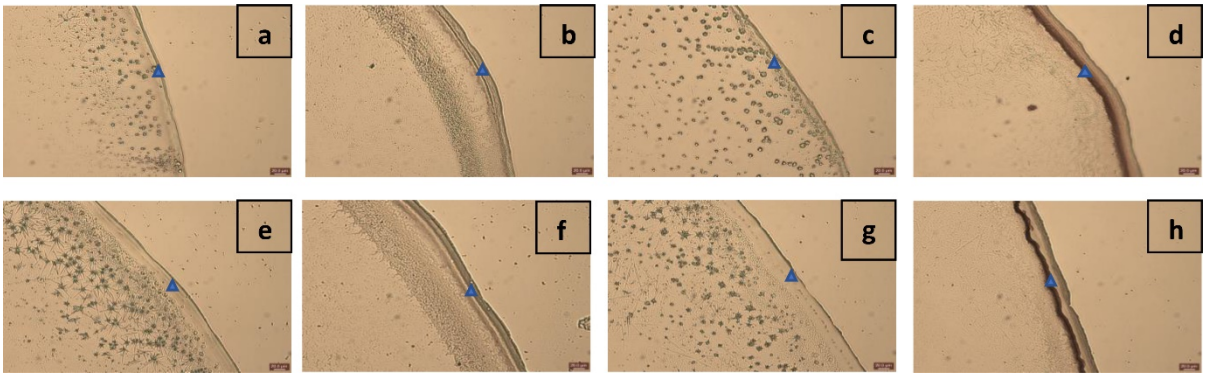


Figure S2 Coffee ring effect upon drying of AgCysNPs. AgCysNPs were dried to test for the coffee ring effect as described in Methods. All images were taken at 200x magnification with scale bar of 20 microns indicated (bottom right of each panel). Arrowheads indicate the major coffee ring layer for each sample, with the pellets of both room temperature conditions (panels **S-1d** and **S-1h**) demonstrating the most color. Synthesis conditions= 37 °C and 2parts Ag + 2parts Cys for supernatant (**a**) and pellet (**b**); 1A= 25 °C and 2parts Ag + 2parts Cys for supernatant (**c**) and pellet (**d**); 37 °C and 3parts Ag + 3parts Cys for supernatant (**e**) and pellet (**f**); and 25 °C and 3parts Ag + 3parts Cys for supernatant (**g**) and pellet (**h**).

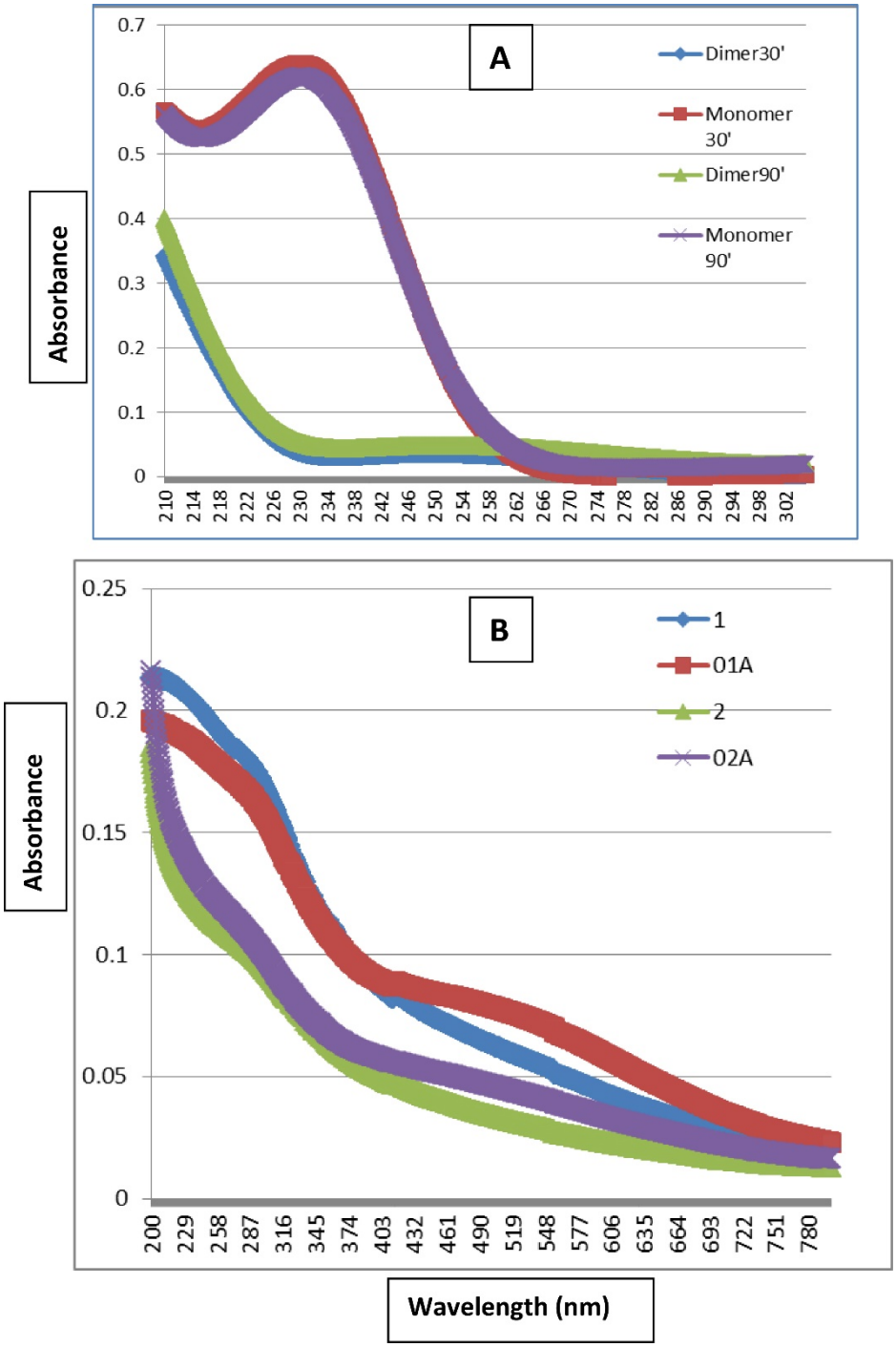


Figure S3 Absorbance of linking amino acids and silver nanoparticles (AgCysNPs). **A**: UV-Visible spectra were carried out on the dimer (cystine) or monomer (cysteine) dissolved in NaOH at 37 °C for 30 or 90 minutes as indicated. **B**: Different formulations of AgCysNPs after washing with water and centrifugation for 3 cycles were scanned for absorbance in the UV-Visible range as indicated. Sample 1= synthesis at 37 °C with a silver:cystine ratio of 2+2; 01A= the same ratio at 25 °C; Sample 2= 37 °C with a ratio of 3+3; and 02A= the same ratio at 25 °C.

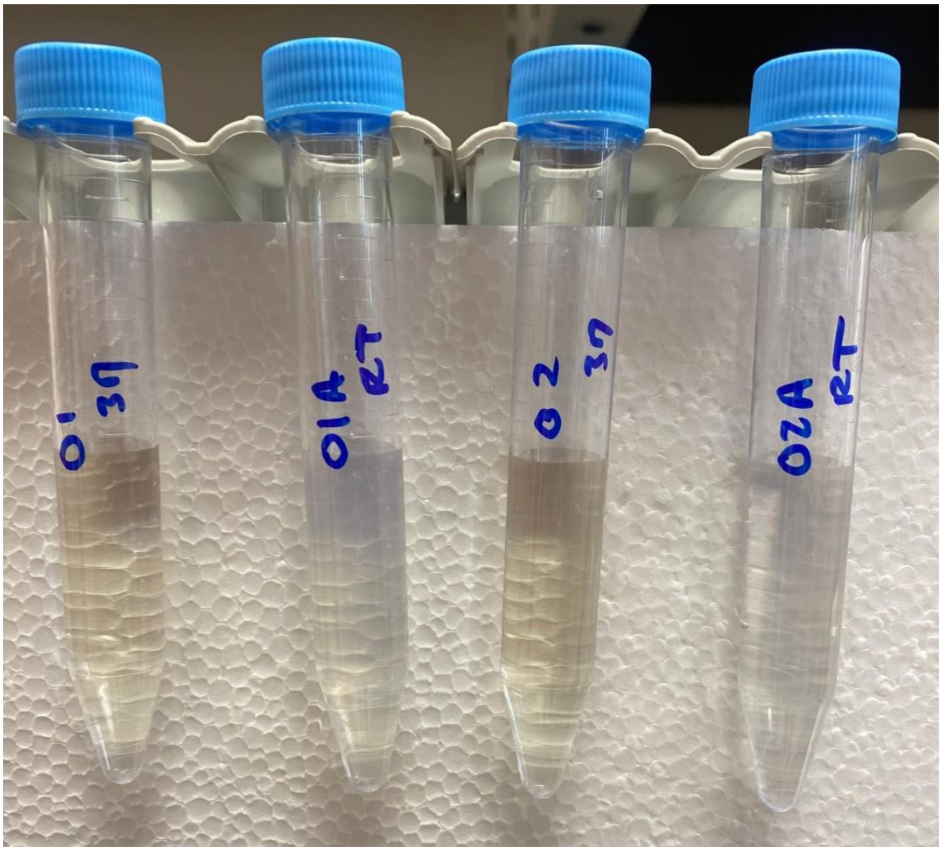


Figure S4 AgCysNPs synthesized under darkened conditions. AgCysNPs were synthesized as described in Methods with all conditions carried out in the dark. Synthesis conditions are shown in the tubes from left to right with Ag:Cys ratios as described in methods and as indicated: **tube 01**, 2Ag+2Cys, 37 °C; **tube 01A**, 2Ag+2Cys, room temperature; **tube 02**, 3Ag+3Cys, 37 °C; and **tube 02A**, 3Ag+3Cys, room temperature.

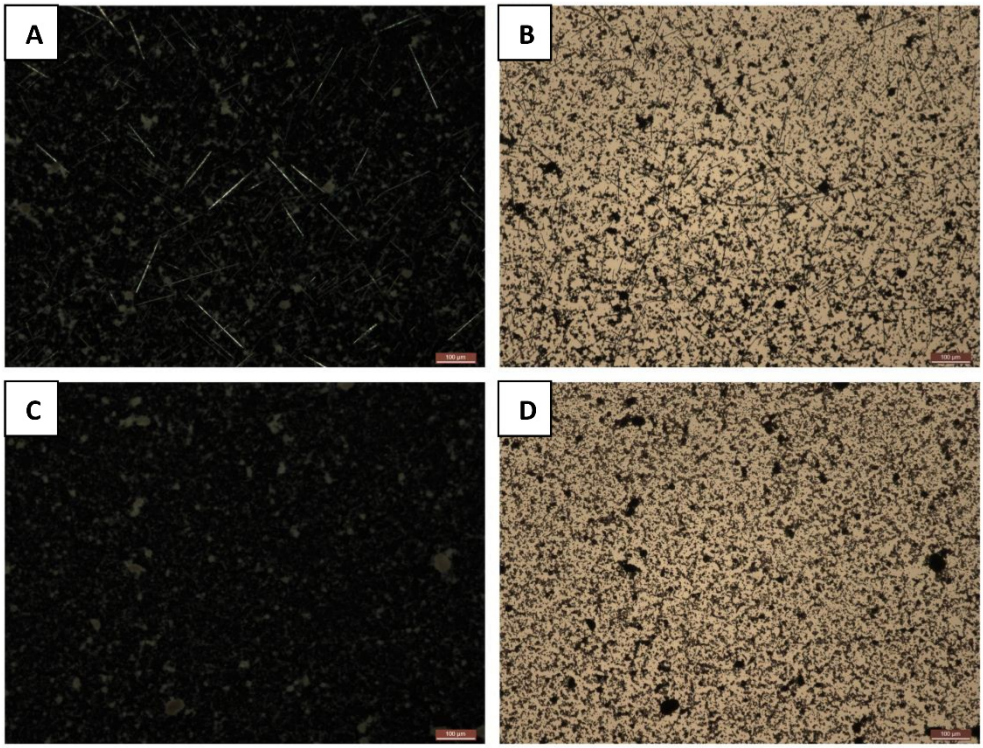


Figure S5 Comparative generation of MOBs types at 37 °C vs room temperature. Cobalt and copper were used for MOBs synthesis simultaneously in the same vessel as described in Methods. Selective generation of different types of MOBs occurred under these conditions only due to temperature as shown. Panels **A+B** show synthesis conditions occurring at room temperature; both cobalt MOBs and CuHARs are generated. CuHARs are readily apparent in (**A**) using polarized light. In contrast, synthesis at 37 °C results in only cobalt MOBs with no CuHARs apparent in brightfield (**D**) or polarized light (**C**). Scale bars in all figure indicate 100 microns.

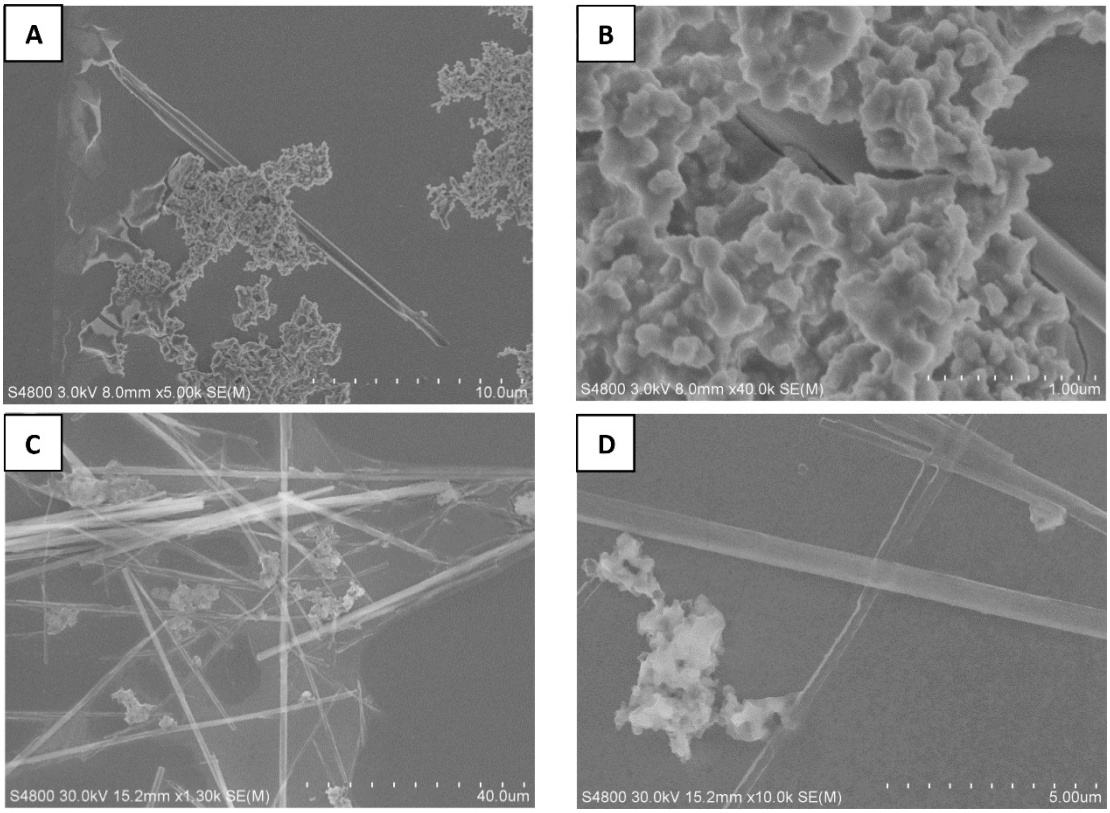
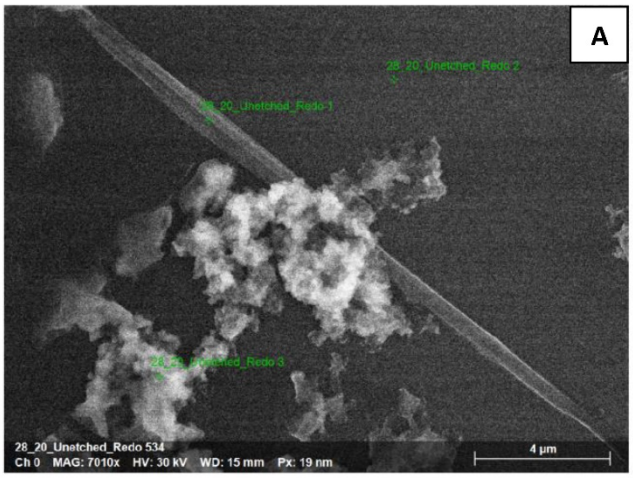
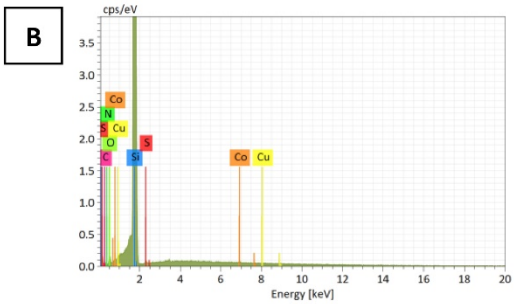


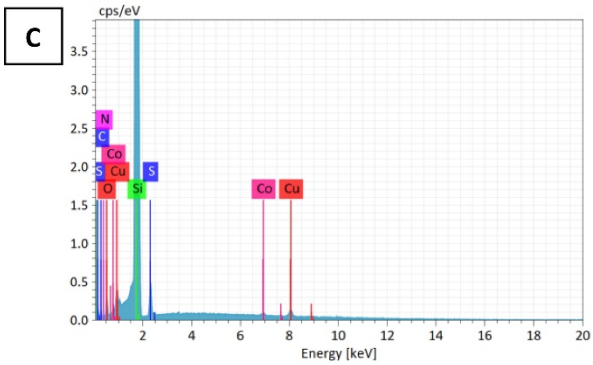
Figure S6 Scanning electron microscopy of cobalt metal organic biohybrids (CoMOBs) co-synthesized with copper high-aspect ratio structures (CuHARS). Panel A shows a wide view of sample with high % of CoMOBs and one prominent CuHARS; scale bar is 10 microns with 1 micron gradations. Panel B is magnified region of sample in panel A, with scale bar gradations of 100 nm. Panel C shows a wide view of sample high in % of CuHARS with mixed CoMOBs also present; scale bar gradations are 4 microns. Panel D is magnified region of sample in panel C, with scale bar gradations of 500 nm.





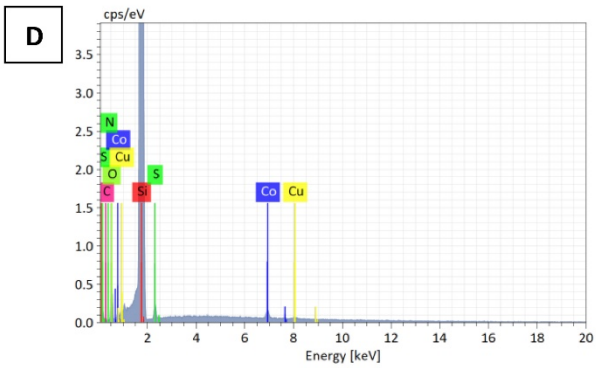
28_20_Unetched_Redo 2

Element	At. No.	Netto	Mass [%]	Mass Norm. [%]	Atom [%]	abs. error [%] (1 sigma)	rel. error [%] (1 sigma)
Carbon	6	798	5.93	4.55	9.72	1.46	24.58
Nitrogen	7	265	1.90	1.46	2.68	0.68	35.87
Oxygen	8	1370	3.53	2.71	4.35	0.76	21.51
Silicon	14	825858	118.33	90.88	82.98	5.28	4.47
Sulfur	16	641	0.37	0.28	0.23	0.05	12.86
Cobalt	27	399	0.13	0.10	0.04	0.03	25.21
Copper	29	30	0.01	0.01	0.00	0.00	18.79
		Sum	130.20	100.00	100.00		



28_20_Unetched_Redo 1

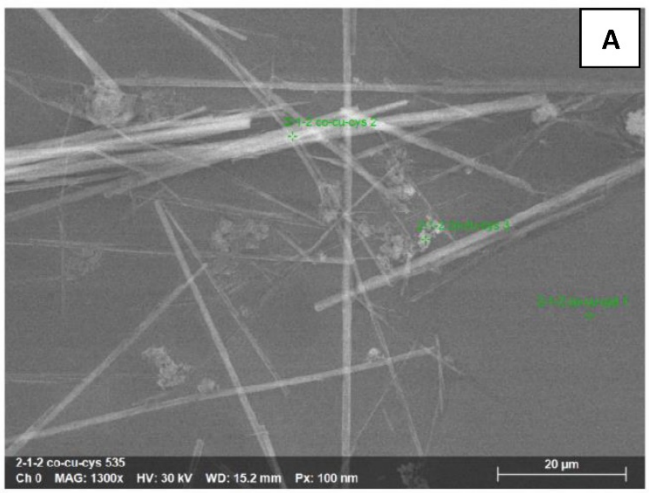
Element	At. No.	Netto	Mass [%]	Mass Norm. [%]	Atom [%]	abs. error [%] (1 sigma)	rel. error [%] (1 sigma)
Carbon	6	1283	9.30	6.63	13.68	1.99	21.44
Nitrogen	7	338	2.40	1.71	3.03	0.79	32.80
Oxygen	8	2537	6.52	4.65	7.20	1.19	18.32
Silicon	14	795273	117.70	83.88	74.01	5.26	4.47
Sulfur	16	6971	3.15	2.24	1.73	0.15	4.81
Cobalt	27	939	0.30	0.21	0.09	0.04	12.61
Copper	29	2582	0.95	0.68	0.26	0.06	5.89
		Sum	140.32	100.00	100.00		

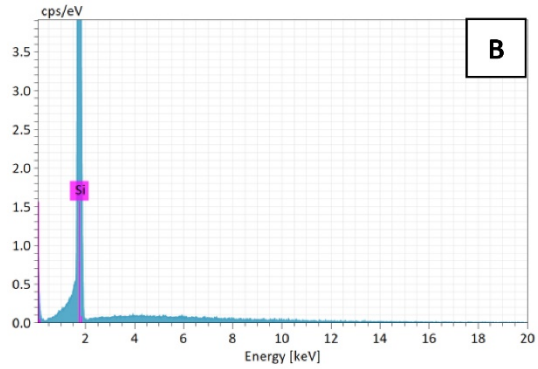


28_20_Unetched_Redo 3

Element	At. No.	Netto	Mass [%]	Mass Norm. [%]	Atom [%]	abs. error [%] (1 sigma)	rel. error [%] (1 sigma)
Carbon	6	543	4.43	3.10	6.58	1.23	27.73
Nitrogen	7	223	1.71	1.20	2.18	0.65	38.26
Oxygen	8	3707	10.10	7.07	11.26	1.70	16.82
Silicon	14	746505	124.10	86.84	78.82	5.54	4.46
Sulfur	16	2988	1.54	1.08	0.86	0.09	6.02
Cobalt	27	2633	0.85	0.59	0.26	0.05	6.23
Copper	29	494	0.17	0.12	0.05	0.03	20.26
		Sum	142.89	100.00	100.00		

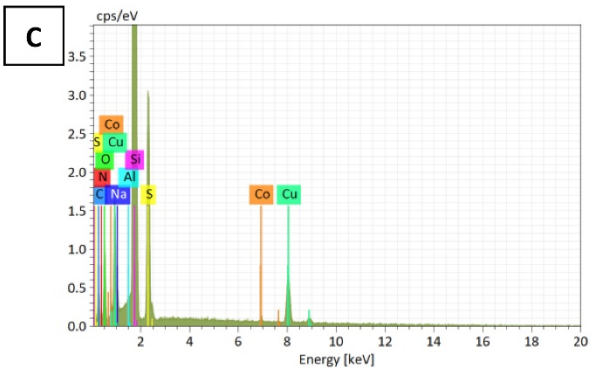
Figure S7 Energy dispersive X-ray spectroscopy (EDX) analysis of cobalt and copper MOBs- Sample high in CoMOBs %. Panel A shows scanned area. B= background analysis of silicon wafer ("redo 2"). C= analyzed region (redo 1)= CuHARS showing higher % of copper and sulfur. D= analyzed region (redo 3)= CoMOBs showing higher % of cobalt and less copper than for CuHARS region.





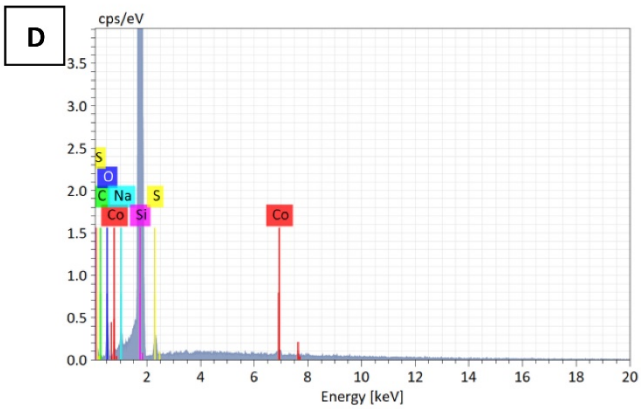
2-1-2 co-cu-cys 1

Element	At. No.	Netto	Mass [%]	Mass Norm. [%]	Atom [%]	abs. error [%] (1 sigma)	rel. error [%] (1 sigma)
Silicon	14	281395	117.04	100.00	100.00	5.23	4.47
		Sum	**117.04**	**100.00**	**100.00**		



2-1-2 co-cu-cys 2

Element	At. No.	Netto	Mass [%]	Mass Norm. [%]	Atom [%]	abs. error [%] (1 sigma)	rel. error [%] (1 sigma)
Carbon	6	1424	19.19	14.57	26.01	3.98	20.73
Nitrogen	7	464	6.56	4.98	7.62	1.90	28.96
Oxygen	8	3233	17.53	13.32	17.85	3.01	17.18
Sodium	11	996	0.79	0.60	0.56	0.09	11.71
Aluminium	13	528	0.19	0.15	0.12	0.04	20.86
Silicon	14	202457	70.32	53.41	40.77	3.16	4.49
Sulfur	16	15337	10.70	8.13	5.44	0.44	4.08
Cobalt	27	299	0.27	0.21	0.07	0.04	15.83
Copper	29	5434	6.10	4.63	1.56	0.20	3.27
		Sum	**131.65**	**100.00**	**100.00**		



2-1-2 co-cu-cys 3

Element	At. No.	Netto	Mass [%]	Mass Norm. [%]	Atom [%]	abs. error [%] (1 sigma)	rel. error [%] (1 sigma)
Carbon	6	123	2.86	2.14	4.61	1.34	46.94
Oxygen	8	1421	10.65	7.99	12.91	2.22	20.84
Sodium	11	666	0.72	0.54	0.61	0.09	12.63
Silicon	14	248995	116.62	87.44	80.49	5.22	4.47
Sulfur	16	1299	2.02	1.52	1.22	0.13	6.34
Cobalt	27	509	0.49	0.37	0.16	0.05	10.42
		Sum	**133.37**	**100.00**	**100.00**		

Figure S8 Energy dispersive X-ray spectroscopy (EDX) analysis of cobalt and copper MOBs- Sample high in CuHARS %. Panel A shows scanned area. B= background analysis of silicon wafer with no other metals present. C= analyzed region 2= CuHARS showing higher % of copper and sulfur and much less cobalt. D= analyzed region 3= CoMOBs showing higher % of cobalt and no copper in this analyzed region but still sulfur.

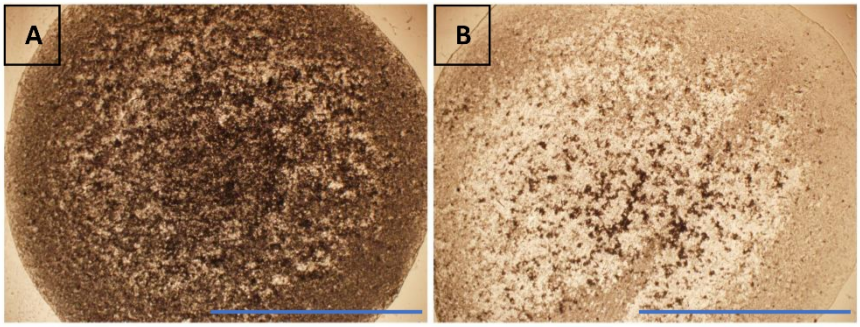


Figure S9 Drying pattern of Cobalt/Copper MOBs without magnetic field (controls). Cobalt and copper containing MOBs were synthesized as described in methods. A 20 µl sample of Co/Cu MOBs mixture (**A**), was dried at room temperature and imaged using brightfield microscopy at 20x magnification. Sample in (**B**) was identical Co/Cu MOBs mixture as shown in (**A**), but diluted 2-fold in water, and then dried under identical conditions. Scale bars= 3.3 mm.