Effect of acid concentration on pore size in polymer-templated mesoporous alumina

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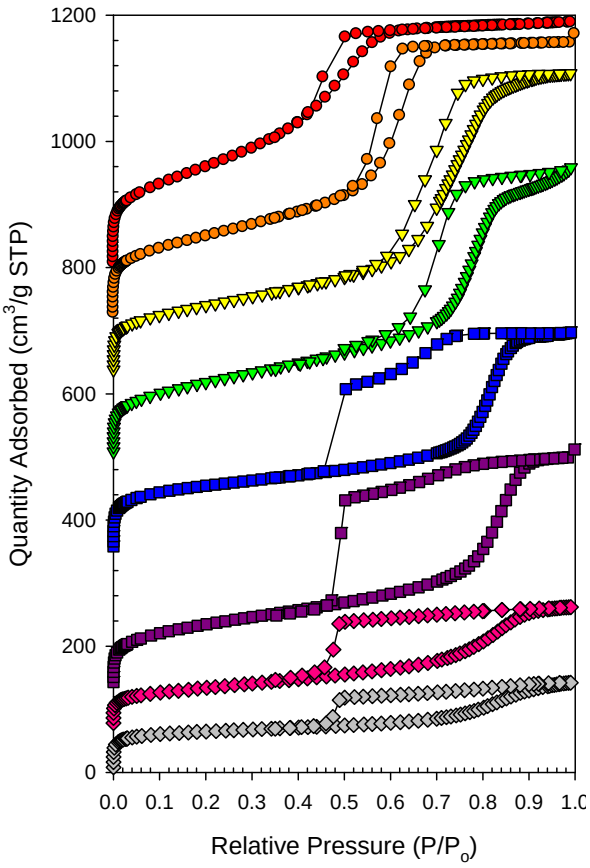

Figure S1 (left)**.** Nitrogen adsorption isotherms for alumina samples calcined at 400°C with 0.6, 1.2, 1.8, 2.4, 3.0, 3.2, 3.6 and 4.8 moles of nitric acid for every mole of aluminum added to the synthesis mixture. Isotherms have been offset by 800, 720, 630, 500, 350, 135 and 70 cm^3/g STP, respectively.

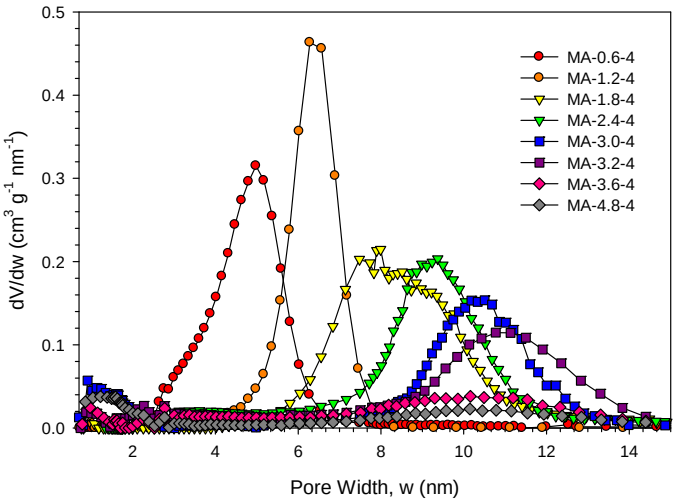

Figure S2 (right)**.** Pore size distributions (PSDs) for alumina samples calcined at 400°C with 0.6, 1.2, 1.8, 2.4, 3.0, 3.2, 3.6 and 4.8 moles of nitric acid for every mole of aluminum added to the synthesis mixture.

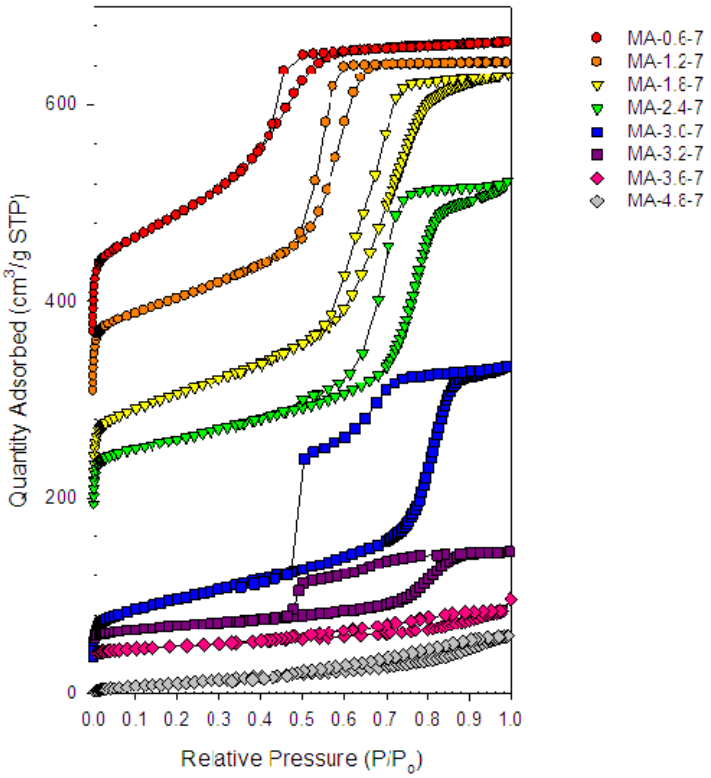

Figure S3. Nitrogen adsorption isotherms for alumina samples calcined at 700°C with 0.6, 1.2, 1.8, 2.4, 3.0, 3.2, 3.6 and 4.8 moles of nitric acid for every mole of aluminum added to the synthesis mixture. Isotherms have been offset by 360, 300, 210, 185, 30, 50 and 40 cm^3/g STP, respectively.

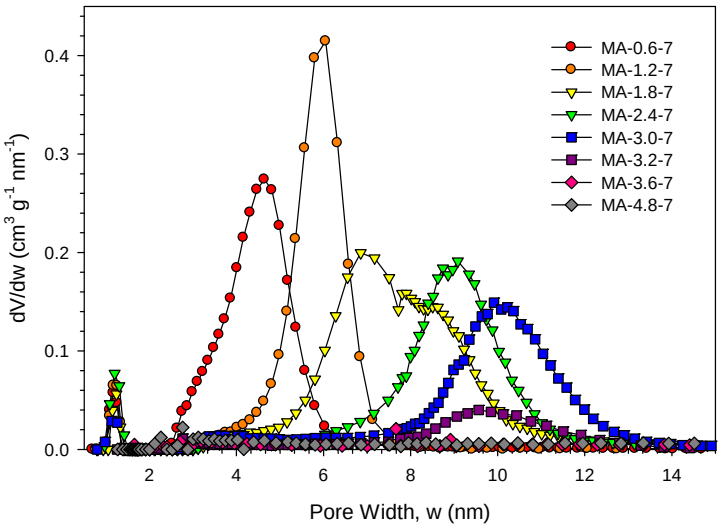

Figure S4. Pore size distributions (PSDs) for alumina samples calcined at 700°C with 0.6, 1.2, 1.8, 2.4, 3.0, 3.2, 3.6 and 4.8 moles of nitric acid for every mole of aluminum added to the synthesis mixture.

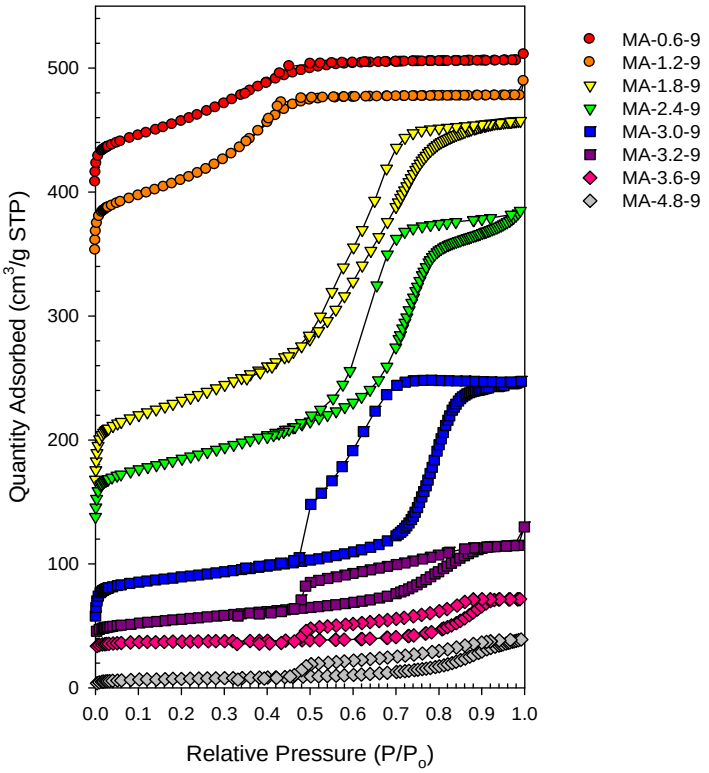

Figure S5. Nitrogen adsorption isotherms for alumina samples calcined at 900°C with 0.6, 1.2, 1.8, 2.4, 3.0, 3.2, 3.6 and 4.8 moles of nitric acid for every mole of aluminum added to the synthesis mixture. Isotherms have been offset by 400, 345, 160, 130, 50, 40 and 30 cm^3/g STP, respectively.

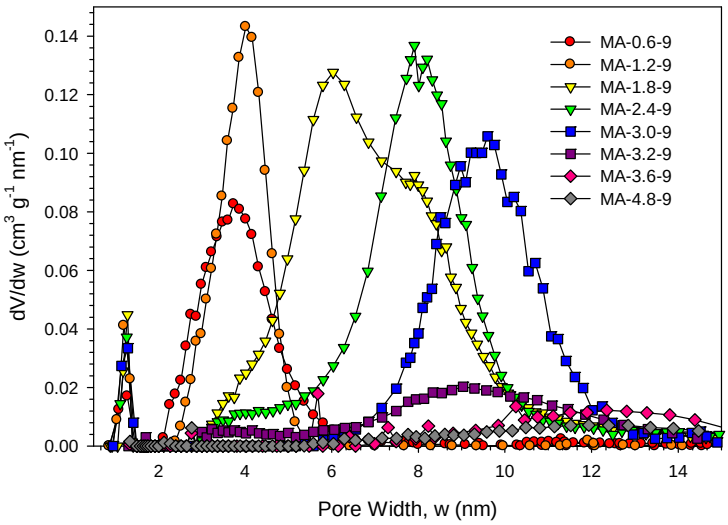

Figure S6. Pore size distributions (PSDs) for alumina samples calcined at 900°C with 0.6, 1.2, 1.8, 2.4, 3.0, 3.2, 3.6 and 4.8 moles of nitric acid for every mole of aluminum added to the synthesis mixture.

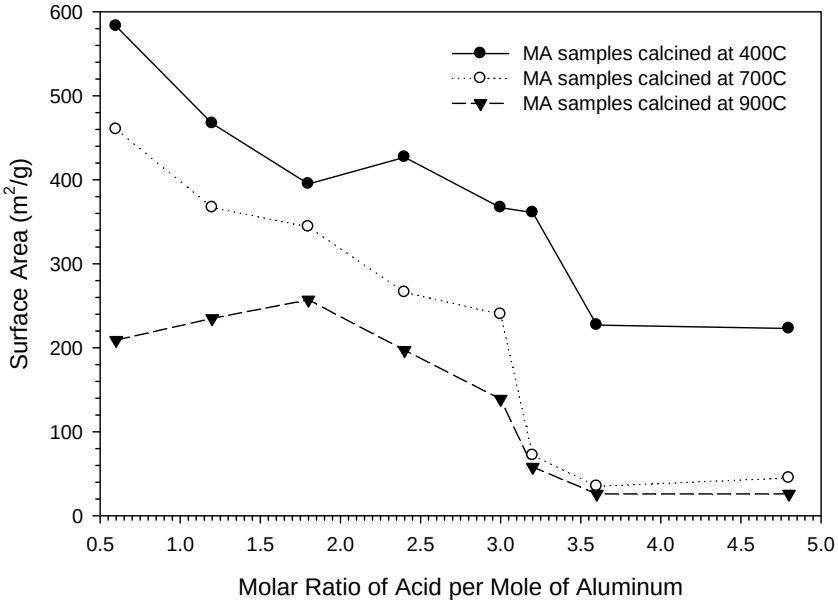

Figure S7. A comparison of the surface area plotted as a function of the molar ratio of acid for all samples studied.

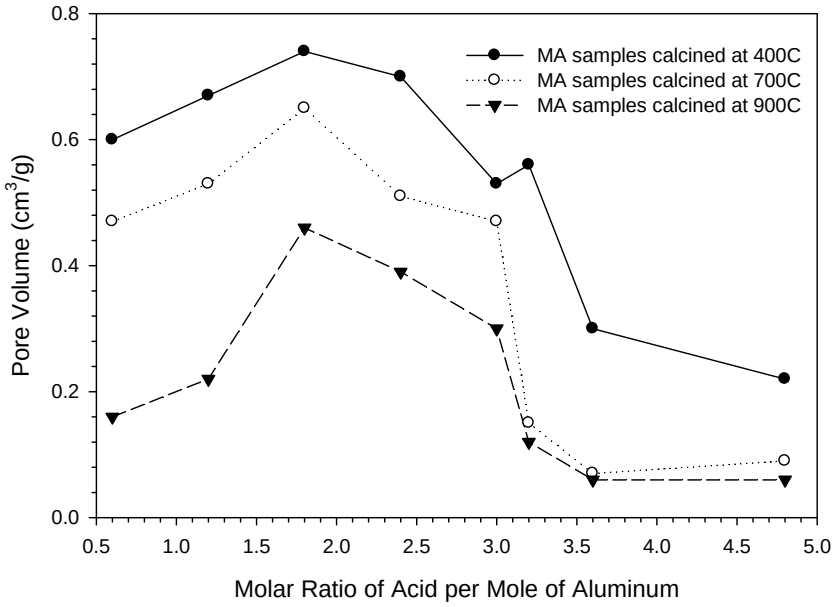

Figure S8. A comparison of the pore volume plotted as a function of the molar ratio of acid for all samples studied.

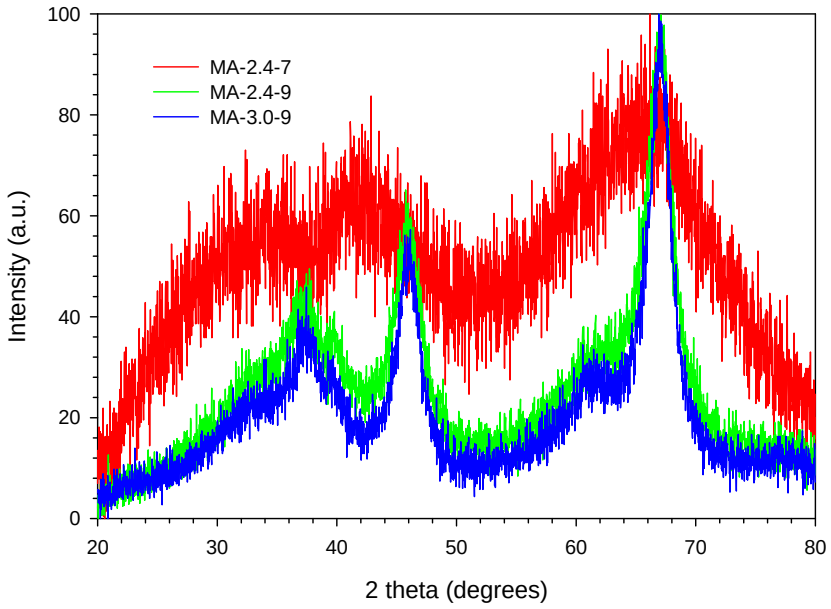

Figure S9. Wide angle X-ray diffraction patterns for the MA-2.4 samples calcined at 700 and 900°C and MA-3.0 sample calcined at 900°C. Peaks for both MA-2.4-9 and MA-3.0-9 are assigned to γ-alumina (JCPDS 1-75-921).

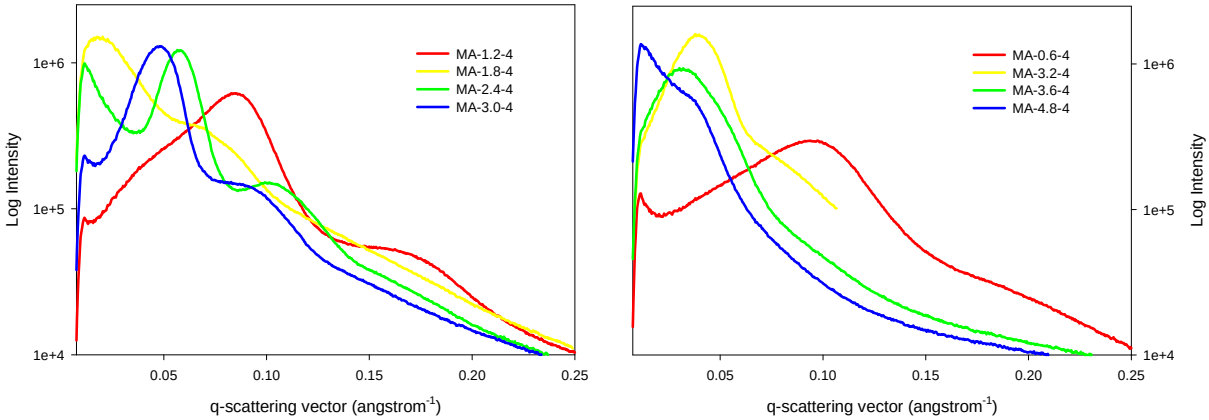

Figure S10. SAXS data for alumina samples calcined at 400°C with (left) 1.2, 1.8, 2.4 and 3.0 and (right) 0.6, 3.2, 3.6 and 4.8 moles of nitric acid for every mole of aluminum added to the synthesis mixture.

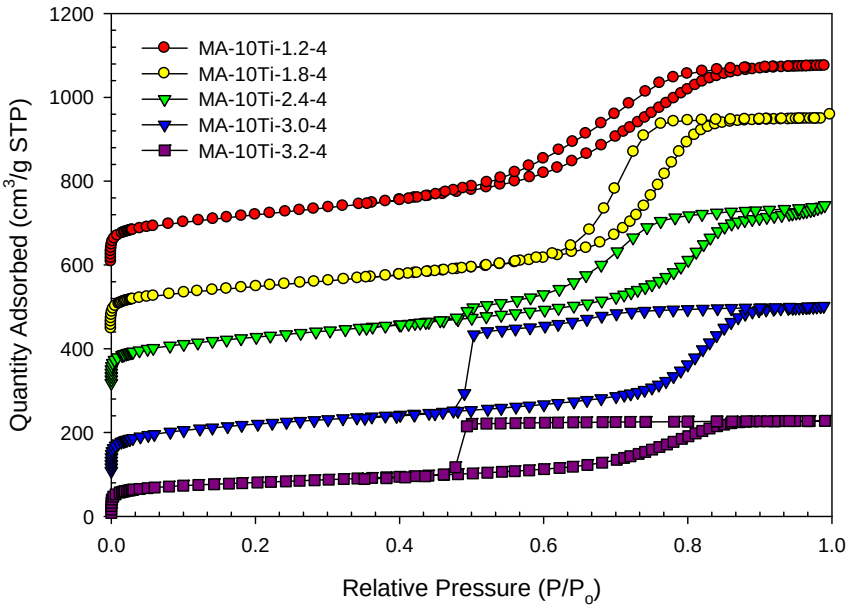

Figure S11. Nitrogen adsorption isotherms for 10% titanium – aluminum oxide samples calcined at 400°C with 1.2, 1.8, 2.4, 3.0 and 3.2 moles of nitric acid for every mole of metal added to the synthesis mixture. MA-10Ti-1.2-4 has been offset by 600 cm^3/g STP, MA-10Ti-1.8-4 by 435 cm^3/g STP, MA-10Ti-2.4-4 by 310 cm^3/g STP and MA-10Ti-3.0-4 by 100 cm^3/g STP.

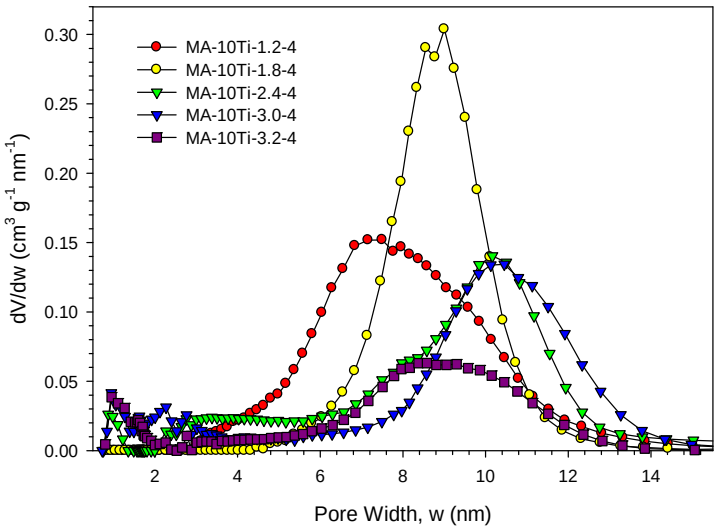

Figure S12. Pore size distributions (PSDs) for 10% titanium-aluminum oxide samples calcined at 400°C with 1.2, 1.8, 2.4, 3.0 and 3.2 moles of nitric acid for every mole of metal added to the synthesis mixture.

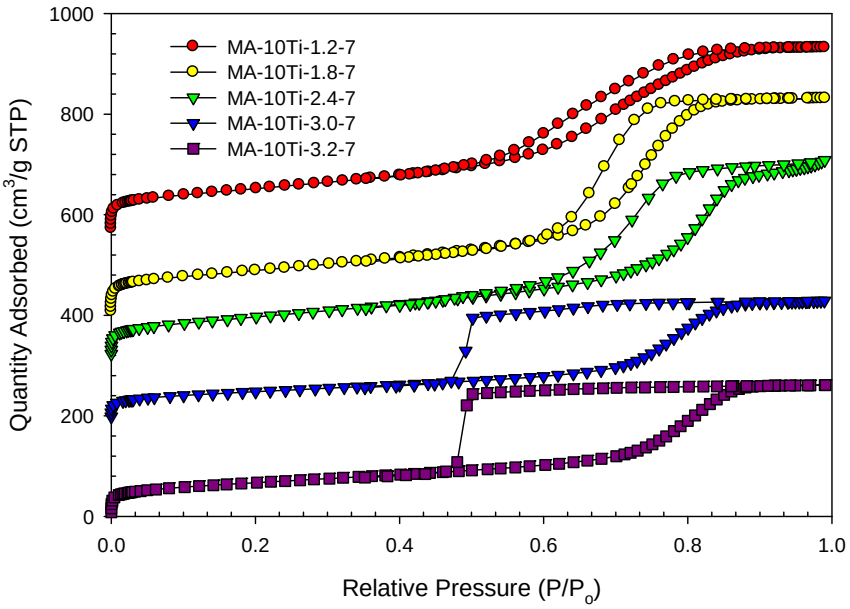

Figure S13. Nitrogen adsorption isotherms for 10% titanium – aluminum oxide samples calcined at 700°C with 1.2, 1.8, 2.4, 3.0 and 3.2 moles of nitric acid for every mole of metal added to the synthesis mixture. MA-10Ti-1.2-7 has been offset by 565 cm^3/g STP, MA-10Ti-1.8-7 by 400 cm^3/g STP, MA-10Ti-2.4-7 by 305 cm^3/g STP and MA-10Ti-3.0-700 by 190 cm^3/g STP.

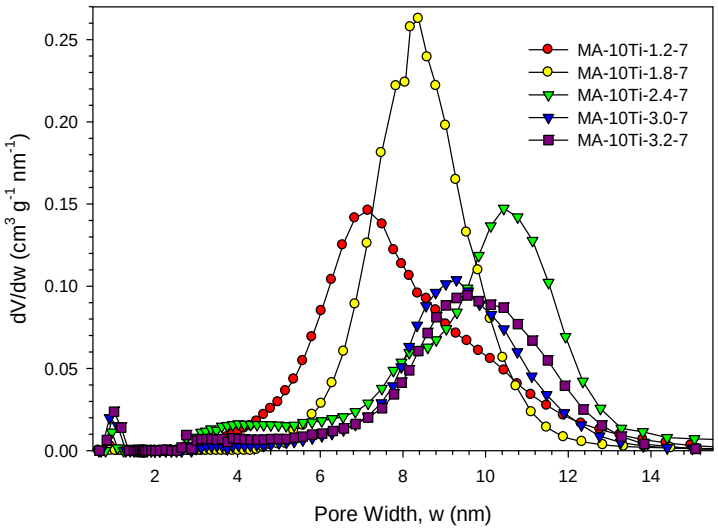

Figure S14. Pore size distributions (PSDs) for 10% titanium-aluminum oxide samples calcined at 700°C with 1.2, 1.8, 2.4, 3.0 and 3.2 moles of nitric acid for every mole of metal added to the synthesis mixture.

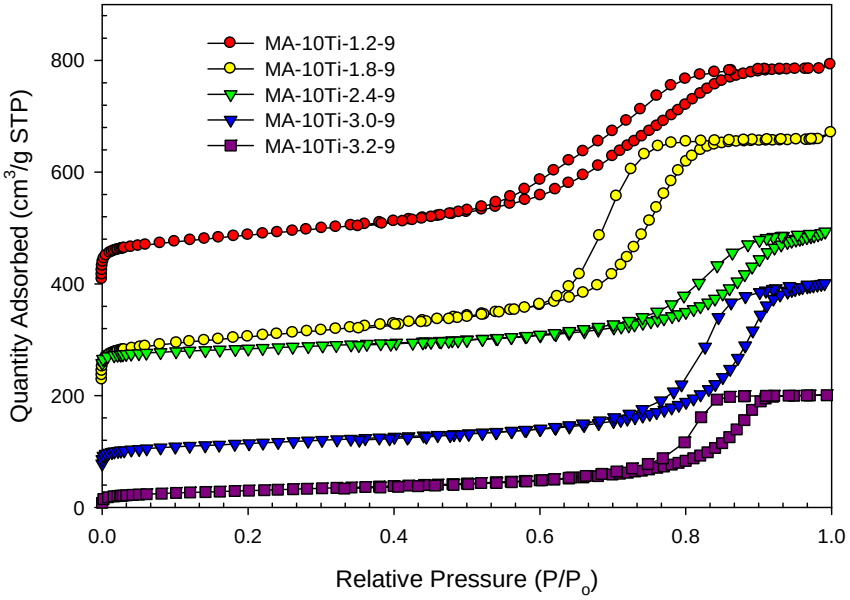

Figure S15. Nitrogen adsorption isotherms for 10% titanium – aluminum oxide samples calcined at 900°C with 1.2, 1.8, 2.4, 3.0 and 3.2 moles of nitric acid for every mole of metal added to the synthesis mixture. MA-10Ti-1.2-9 has been offset by 400 cm^3/g STP, MA-10Ti-1.8-9 by 220 cm^3/g STP, MA-10Ti-2.4-9 by 250 cm^3/g STP and MA-10Ti-3.0-9 by 70 cm^3/g STP.

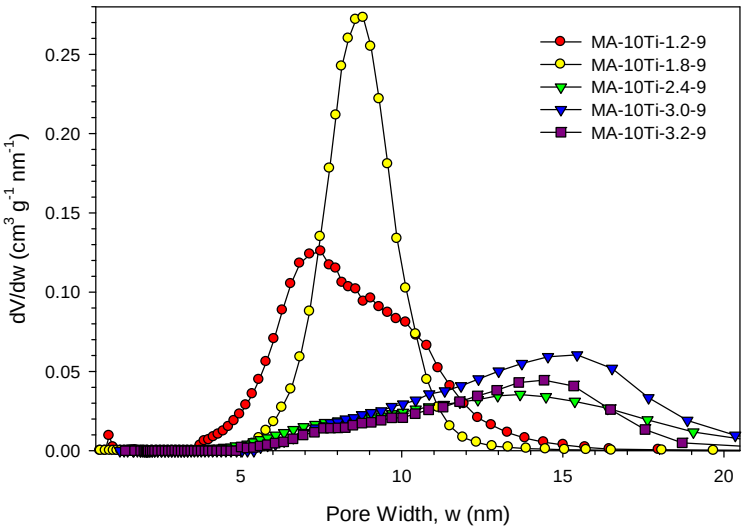

Figure S16. Pore size distributions (PSDs) for 10% titanium-aluminum oxide samples calcined at 900°C with 1.2, 1.8, 2.4, 3.0 and 3.2 moles of nitric acid for every mole of metal added to the synthesis mixture.

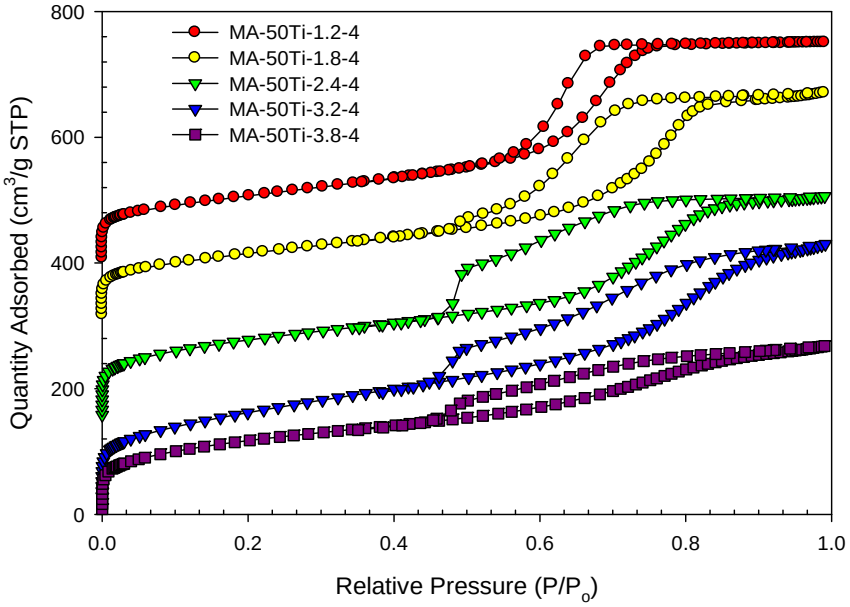

Figure S17. Nitrogen adsorption isotherms for 50% titanium – aluminum oxide samples calcined at 400°C with 1.2, 1.8, 2.4, 3.2 and 3.8 moles of nitric acid for every mole of metal added to the synthesis mixture. MA-50Ti-1.2-4 has been offset by 400 cm^3/g STP, MA-50Ti-1.8-4 offset by 310 cm^3/g STP, MA-50Ti-2.4-4 offset by 150 cm^3/g STP, MA-50Ti-3.2-4 offset by 20 cm^3/g STP.

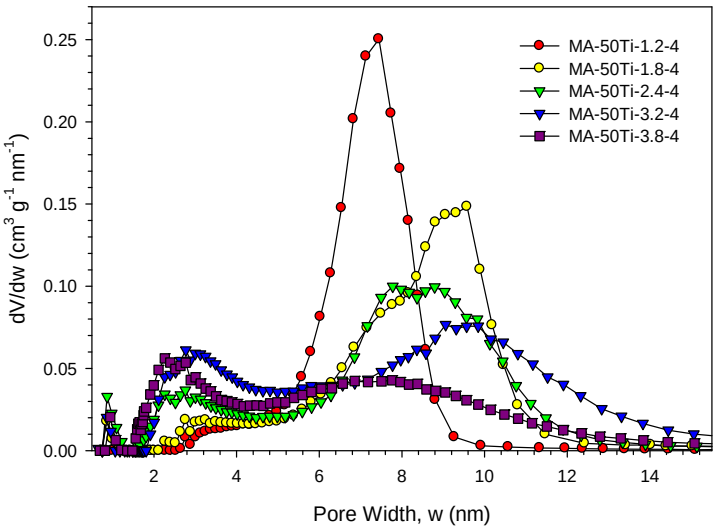

Figure S18. Pore size distributions (PSDs) for 50% titanium-aluminum oxide samples calcined at 400°C with 1.2, 1.8, 2.4, 3.2 and 3.8 moles of nitric acid for every mole of metal added to the synthesis mixture.

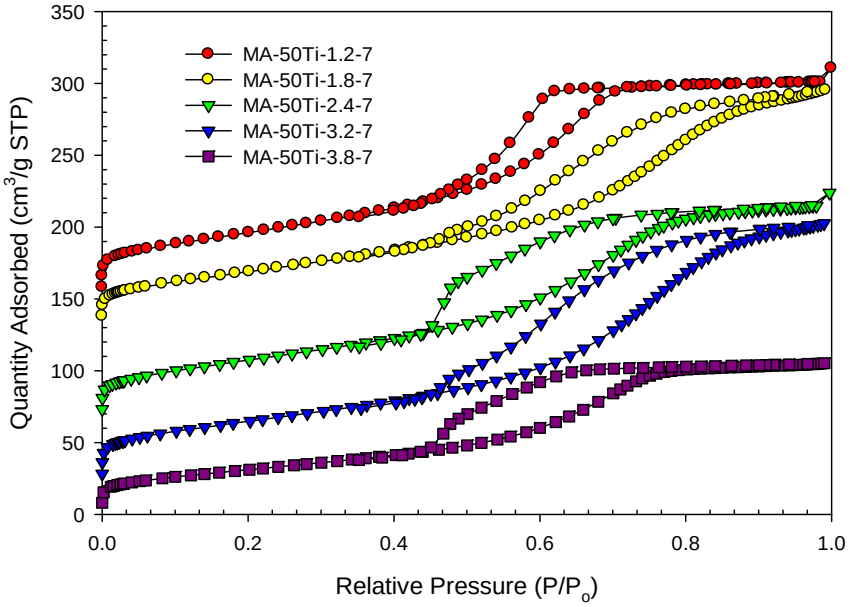

Figure S19. Nitrogen adsorption isotherms for 50% titanium – aluminum oxide samples calcined at 700°C with 1.2, 1.8, 2.4, 3.2 and 3.8 moles of nitric acid for every mole of metal added to the synthesis mixture. MA-50Ti-1.2-7 has been offset by 150 cm^3/g STP, MA-50Ti-1.8-7 by 130 cm^3/g STP, MA-50Ti-2.4-7 by 65 cm^3/g STP and MA-50Ti-3.2-7 by 20 cm^3/g STP.

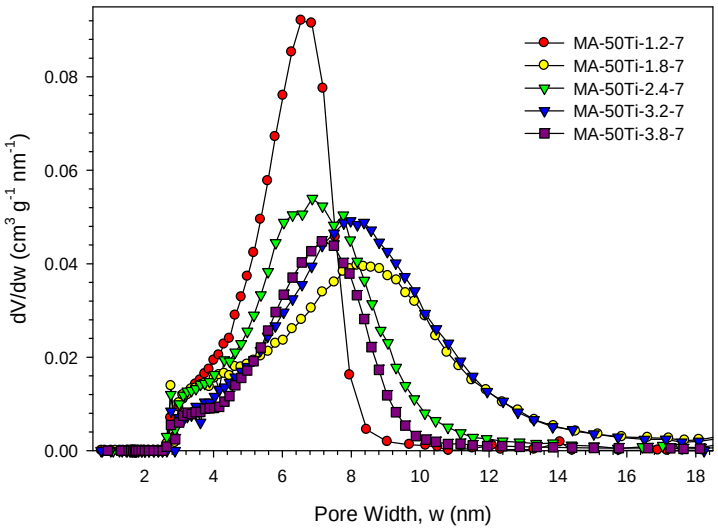

Figure S20. Pore size distributions (PSDs) for 50% titanium-aluminum oxide samples calcined at 700°C with 1.2, 1.8, 2.4, 3.2 and 3.8 moles of nitric acid for every mole of metal added to the synthesis mixture.

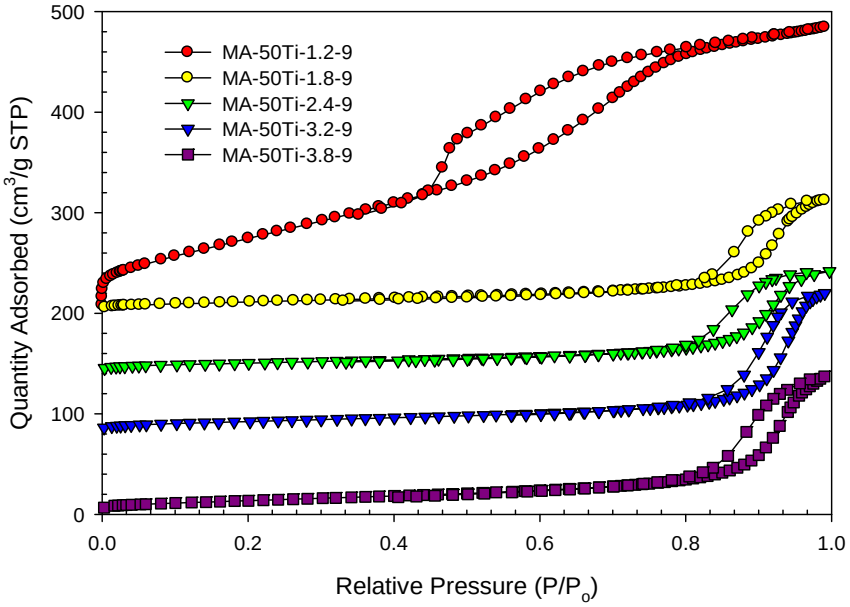

Figure S21. Nitrogen adsorption isotherms for 50% titanium – aluminum oxide samples calcined at 900°C with 1.2, 1.8, 2.4, 3.2 and 3.8 moles of nitric acid for every mole of metal added to the synthesis mixture. MA-50Ti-1.2-9 has been offset by 200 cm^3/g STP, MA-50Ti-1.8-9 by 200 cm^3/g STP, MA-50Ti-2.4-9 by 140 cm^3/g STP and MA-50Ti-3.2-9 by 80 cm^3/g STP.

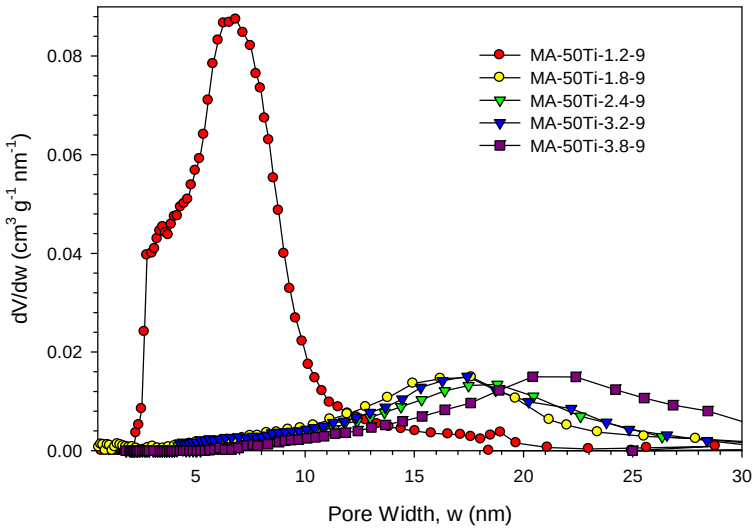

Figure S22. Pore size distributions (PSDs) for 50% titanium-aluminum oxide samples calcined at 900°C with 1.2, 1.8, 2.4, 3.2 and 3.8 moles of nitric acid for every mole of metal added to the synthesis mixture.

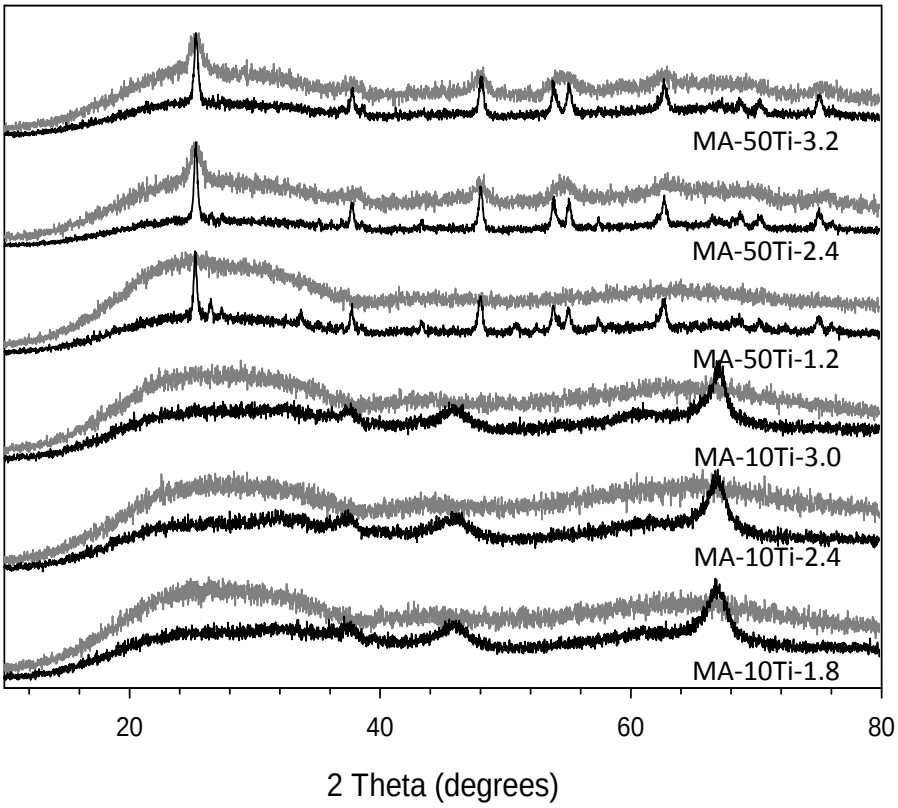

Figure S23. Wide angle XRD patterns of 10% titanium-aluminum oxide samples with 1.8, 2.4 and 3.0 moles of nitric acid for every mole of metal added to the synthesis mixture and 50% titanium-aluminum oxide samples with 1.2, 2.4 and 3.2 moles of nitric acid for every mole of metal added to the synthesis mixture. Gray patterns are for the samples calcined up to 700°C and black patterns are for the samples calcined up to 900°C. The XRD patterns were assigned as follows: MA-10Ti-1.8 (γ-aluminum oxide, JCPDS 01-075-0921), MA-10Ti-2.4 (γ-aluminum oxide, JCPDS 01-079-1558), MA-10Ti-3.0 (γ-aluminum oxide, 01-080-0956), MA-50Ti-1.2 (anatase, JCPDS 00-004-0477 and α-aluminum oxide, JCPDS 01-074-1081), MA-50Ti-2.4 (anatase, JCPDS 00-004-0477 and α-aluminum oxide, JCPDS 01-073-1512) and MA-50Ti-3.2 (anatase, JCPDS 00-021-1272 and α-aluminum oxide, JCPDS 01-074-1081).

Table S1. Adsorption parameters for 10% and 50% titanium-aluminum oxide samples with various molar ratios of acid to metal added to the synthesis mixture, obtained by analysis of nitrogen adsorption isotherms and the corresponding pore size distributions.[b]

Sample	S_{BET} (m^2/g)	V_{sp} (cm^3/g)	V_{mi} (cm^3/g)	w_{KJS} (nm)	Sample	S_{BET} (m^2/g)	V_{sp} (cm^3/g)	V_{mi} (cm^3/g)	w_{KJS} (nm)
MA-10Ti-1.2-4	431	0.73	0.00	7.5	MA-50Ti-1.2-4	383	0.54	0.00	7.4
MA-10Ti-1.2-7	311	0.57	0.00	7.2	MA-50Ti-1.2-7	167	0.23	0.00	6.6
MA-10Ti-1.2-9	311	0.59	0.00	7.5*	MA-50Ti-1.2-9	287	0.44	0.02	6.8
MA-10Ti-1.8-4	388	0.79	0.00	9.0	MA-50Ti-1.8-4	377	0.55	0.01	9.6
MA-10Ti-1.8-7	317	0.67	0.00	8.4	MA-50Ti-1.8-7	143	0.25	0.00	8.2
MA-10Ti-1.8-9	304	0.68	0.00	8.8	MA-50Ti-1.8-9	40	0.17	0.00	17.6±
MA-10Ti-2.4-4	425	0.66	0.02	10.2	MA-50Ti-2.4-4	460	0.55	0.04	7.9*
MA-10Ti-2.4-7	294	0.60	0.00	10.4	MA-50Ti-2.4-7	154	0.23	0.00	6.9
MA-10Ti-2.4-9	122	0.37	0.00	13.7±	MA-50Ti-2.4-9	37	0.16	0.00	18.8±
MA-10Ti-3.0-4	431	0.62	0.05	10.5	MA-50Ti-3.2-4	516	0.63	0.06	9.1*
MA-10Ti-3.0-7	206	0.37	0.01	9.3	MA-50Ti-3.2-7	161	0.28	0.00	8.0
MA-10Ti-3.0-9	159	0.51	0.00	15.5±	MA-50Ti-3.2-9	44	0.21	0.00	20.2±
MA-10Ti-3.2-4	284	0.35	0.03	8.6	MA-50Ti-3.8-4	426	0.41	0.07	7.6*
MA-10Ti-3.2-7	240	0.40	0.01	9.6	MA-50Ti-3.8-7	112	0.16	0.00	7.1
MA-10Ti-3.2-9	108	0.31	0.00	14.4±	MA-50Ti-3.8-9	49	0.21	0.00	20.4±

[b] S_{BET} - BET specific surface area obtained from nitrogen adsorption data in the P/P_o range from 0.05 to 0.2; V_{sp} - single-point pore volume calculated from nitrogen adsorption isotherm at $P/P_o = 0.98$; V_{mi} - complementary pore volume calculated by integration of the PSD curve up to ~3nm; w_{KJS} – pore width calculated at the maximum of PSD; *PSD curves are broad and these values reflect an average mesopore width; ± For the samples with the pore widths above 12 nm a modified version of the improved KJS method, calibrated for cylindrical pores up to ~19 nm, was used for the evaluation of PSD.