Combined Microwave Assisted Roasting and Leaching to Recover Platinum Group Metals from Spent Automotive Catalysts

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Supplementary Data

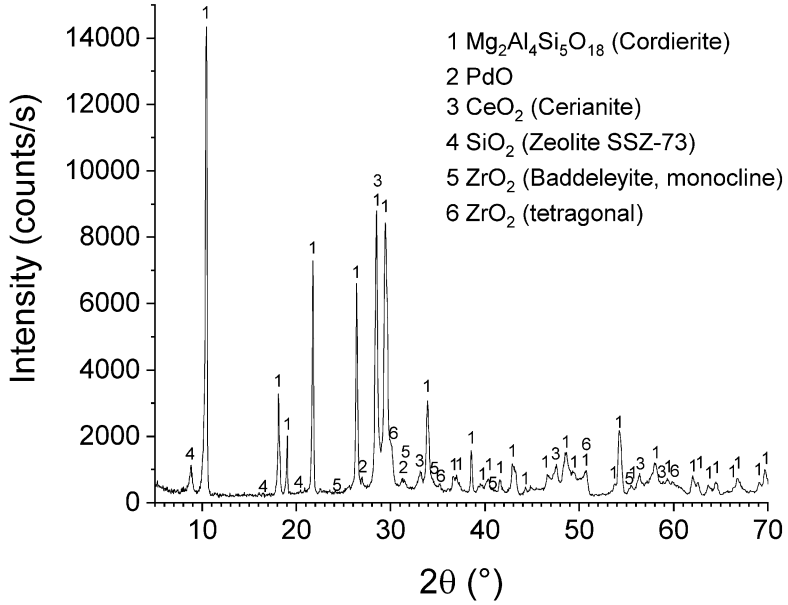

Figure I. X-ray powder diffractogram of a representative sample of milled (<0.16 mm) spent automotive catalysts.

Table I. Tested DoE parameters and measured PGM leachabilities during MW roasting (750 W, 30 min) and subsequent MW leaching (105 °C, 30 min).

Tested parameters (factors)				**PGM leachabilities (%)**		
Salt:catalyst (w/w)	**ClO_3^-:HSO_4^- (mol/mol)**	**Liquid:salt (w/w)**	**[HCl] (M)**	**Pd**	**Pt**	**Rh**
2.5	0.05	5	0.1	51 ±13	4 ±4	54 ±5
2.5	0.05	5	1	77 ±6	32 ±21	72 ±5
2.5	0.05	10	0.1	78 ±0.03	11 ±0.05	57 ±0.6
2.5	0.05	10	1	79 ±2	36 ±0.8	59 ±5
2.5	0.20	5	0.1	79 ±2	11 ±0.8	51 ±0.7
2.5	0.20	5	1	79 ±3	11 ±2	53 ±6
2.5	0.20	10	0.1	64 ±22	8 ±9	41 ±18
2.5	0.20	10	1	78 ±0.7	11 ±2	45 ±2
5.0	0.05	5	0.1	78 ±3	24 ±2	87 ±1
5.0	0.05	5	1	80 ±7	51 ±5	78 ±7
5.0	0.05	10	0.1	81 ±1	31 ±5	74 ±4
5.0	0.05	10	1	86 ±2	69 ±5	89 ±1
5.0	0.20	5	0.1	80 ±0.1	17 ±5	78 ±4
5.0	0.20	5	1	82 ±0.4	32 ±2	86 ±4
5.0	0.20	10	0.1	80 ±0.03	13 ±7	72 ±0.6
5.0	0.20	10	1	82 ±1	49 ±4	66 ±2

Table II. DoE calculated effects and *p*-values of the 4 investigated factors on the Pd, Pt and Rh leachability. The significant ($p < 0.05$) effects are given in bold.

Factor	**Pd**		**Pt**		**Rh**	
	Effect (%)	***p***	**Effect (%)**	***p***	**Effect (%)**	***p***
A	**7.31**	**0.0239**	**19.81**	**0.0000**	**24.29**	**0.0000**
B	2.56	0.4039	**-12.78**	**0.0001**	**-8.85**	**0.0060**
C	3.37	0.2742	**5.89**	**0.0323**	**-6.30**	**0.0412**
D	5.77	0.0682	**21.06**	**0.0000**	3.59	0.2292
AB	-1.38	0.6500	-2.17	0.4073	3.94	0.1884
AC	0.11	0.9721	4.13	0.1232	0.76	0.7949
AD	-4.19	0.1768	**7.00**	**0.0128**	-2.80	0.3447
BC	**-7.24**	**0.0250**	-3.64	0.1715	-4.53	0.1332
BD	-1.14	0.7069	**-7.63**	**0.0074**	-1.56	0.5953
CD	-0.08	0.9787	4.55	0.0914	-0.01	0.9966

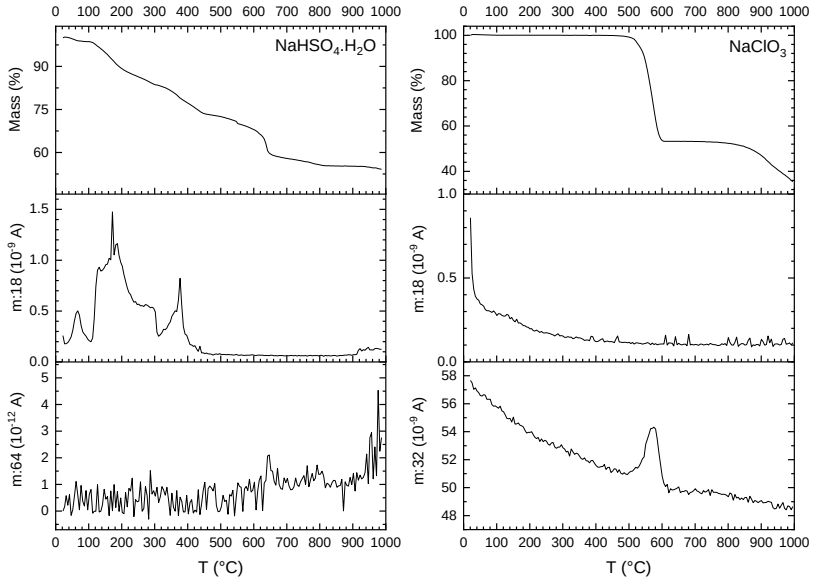

Figure II. TGA-MS analyses of $NaHSO_4 \cdot H_2O$ (left) and $NaClO_3$ (right).

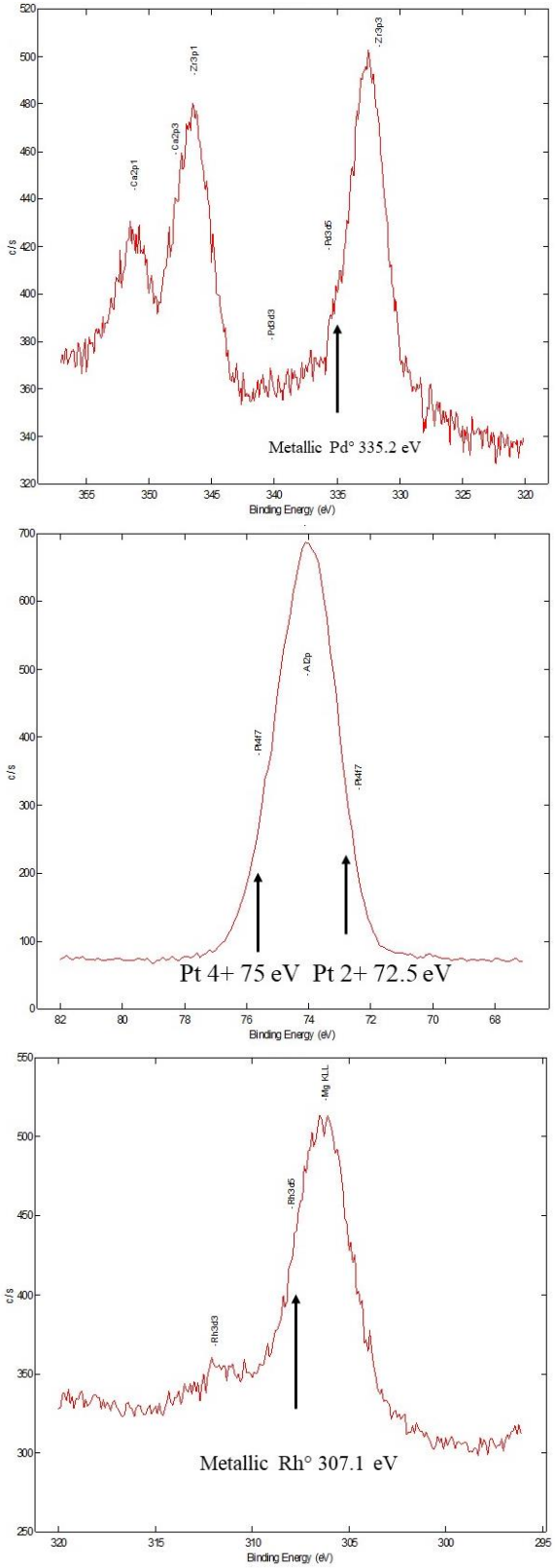

Figure III. XPS analysis of untreated automotive catalyst. Binding energy regions of Pd (top), Pt (middle) and Rh (bottom).

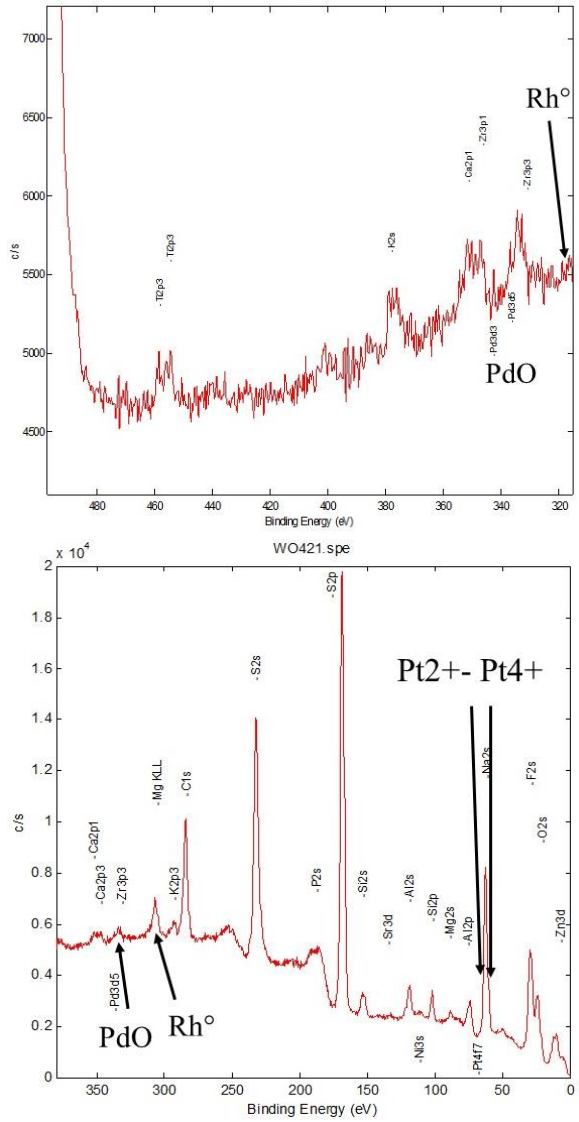

Figure IV. XPS analysis of MW sulfation roasted automotive catalyst. Binding energy regions of Pd and Rh (top) and general overview including binding energies for Pd, Pt and Rh (bottom).