

# Physicochemical analysis of individual atmospheric fine particles based on effective surface-enhanced Raman spectroscopy

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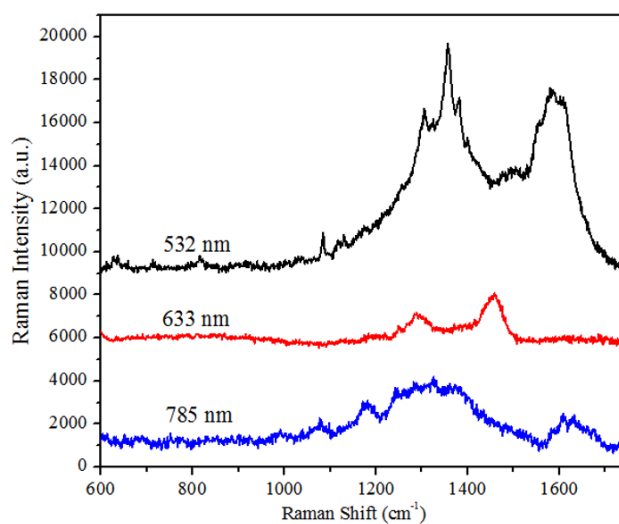
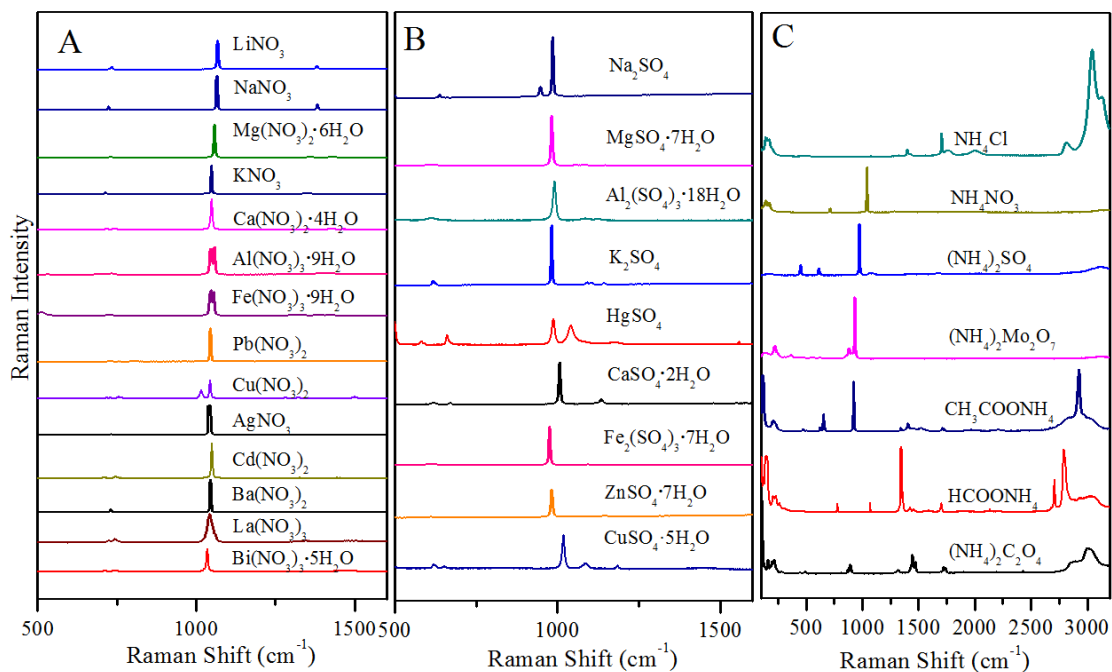


Figure S1 SERS spectra of PM<sub>2.5</sub> under different laser wavelengths.

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**Figure S2.** Standard Raman spectra of nitrates (A), sulfates (B), and ammonium salts (C).

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Table S1. Particle size distribution from the DLPI instrument.

Sample	5	6	7	8	9
D50( $\mu\text{m}$ )	0.400	0.650	1.000	1.600	2.500

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Table S2. Raman peaks of 40 kinds of standard chemicals in Raman database for PM<sub>2.5</sub>.

Group	Chemicals	Raman characteristic Peaks (cm <sup>-1</sup> )
Nitrate	LiNO <sub>3</sub>	735, 1067
	NaNO <sub>3</sub>	724, 1068, 1383
	Mg(NO <sub>3</sub> ) <sub>2</sub> ·6H <sub>2</sub> O	729, 1056
	KNO <sub>3</sub>	715, 1050
	Ca(NO <sub>3</sub> ) <sub>2</sub> ·4H <sub>2</sub> O	742, 1050
	Al(NO <sub>3</sub> ) <sub>3</sub> ·9H <sub>2</sub> O	733, 1047, 1056
	Fe(NO <sub>3</sub> ) <sub>3</sub> ·9H <sub>2</sub> O	513, 1048, 1056
	Pb(NO <sub>3</sub> ) <sub>2</sub>	731, 1043
	Cu(NO <sub>3</sub> ) <sub>2</sub>	717, 765, 1015, 1045
	AgNO <sub>3</sub>	731, 1040
	Cd(NO <sub>3</sub> ) <sub>2</sub>	745, 1052
	Ba(NO <sub>3</sub> ) <sub>2</sub>	733, 1043
	La(NO <sub>3</sub> ) <sub>3</sub>	738, 1045
Bi(NO <sub>3</sub> ) <sub>3</sub> ·5H <sub>2</sub> O	747, 1034	
Sulfate	Na <sub>2</sub> SO <sub>4</sub>	612, 991
	MgSO <sub>4</sub> ·7H <sub>2</sub> O	599, 897, 982, 1004, 1108, 1160
	Al <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub> ·18H <sub>2</sub> O	610, 992, 1085, 1126
	K <sub>2</sub> SO <sub>4</sub>	619, 982, 1106, 1143
	HgSO <sub>4</sub>	582, 662, 987, 1039, 1197
	CaSO <sub>4</sub> ·2H <sub>2</sub> O	620, 671, 1007, 1135
	Fe <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub> ·7H <sub>2</sub> O	615, 976, 1100
	ZnSO <sub>4</sub> ·7H <sub>2</sub> O	610, 982, 1083, 1143
	CuSO <sub>4</sub> ·5H <sub>2</sub> O	610, 982, 1142
Ammonium	NH <sub>4</sub> Cl	1402, 1706, 2006, 2811
	NH <sub>4</sub> NO <sub>3</sub>	714, 1042, 1287
	(NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub>	452, 615, 975
	(NH <sub>4</sub> ) <sub>2</sub> MO <sub>2</sub> O <sub>7</sub>	891, 932
	CH <sub>3</sub> COONH <sub>4</sub>	652, 922, 1406, 2928
	HCOONH <sub>4</sub>	775, 1071, 1345, 2799

	(NH <sub>4</sub> ) <sub>2</sub> C <sub>2</sub> O <sub>4</sub>	490, 894, 1447, 1471
Carbonaceous	graphene	1348, 1577
	graphene oxide	1341, 1581
Oxide	SiO <sub>2</sub>	207, 463
	TiO <sub>2</sub>	397, 516, 637
	Fe <sub>2</sub> O <sub>3</sub>	218, 275, 388
	CaO	359
	Al <sub>2</sub> O <sub>3</sub>	377, 419, 644, 749
	ZnO	333, 438
	Sb <sub>2</sub> O <sub>3</sub>	256, 374, 452
	Cr <sub>2</sub> O <sub>3</sub>	302, 341, 538