

## SUPPORTING INFORMATION

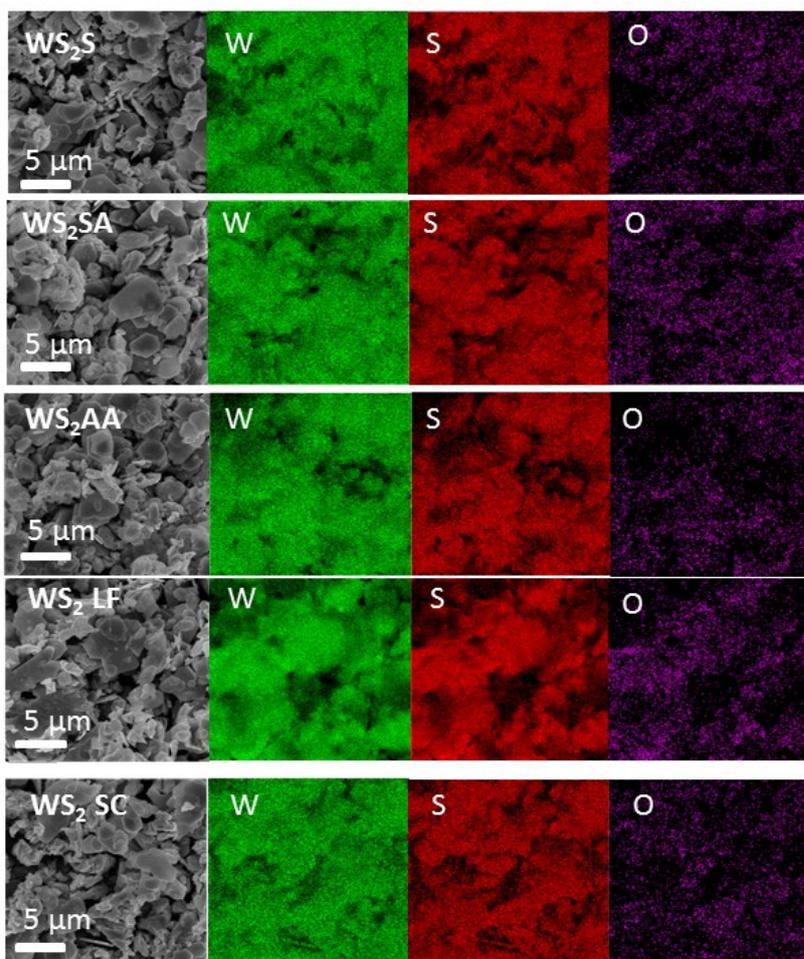
# A Study of the Effect of Sonication Time on Catalytic Performance of Layered WS<sub>2</sub> from Various Sources

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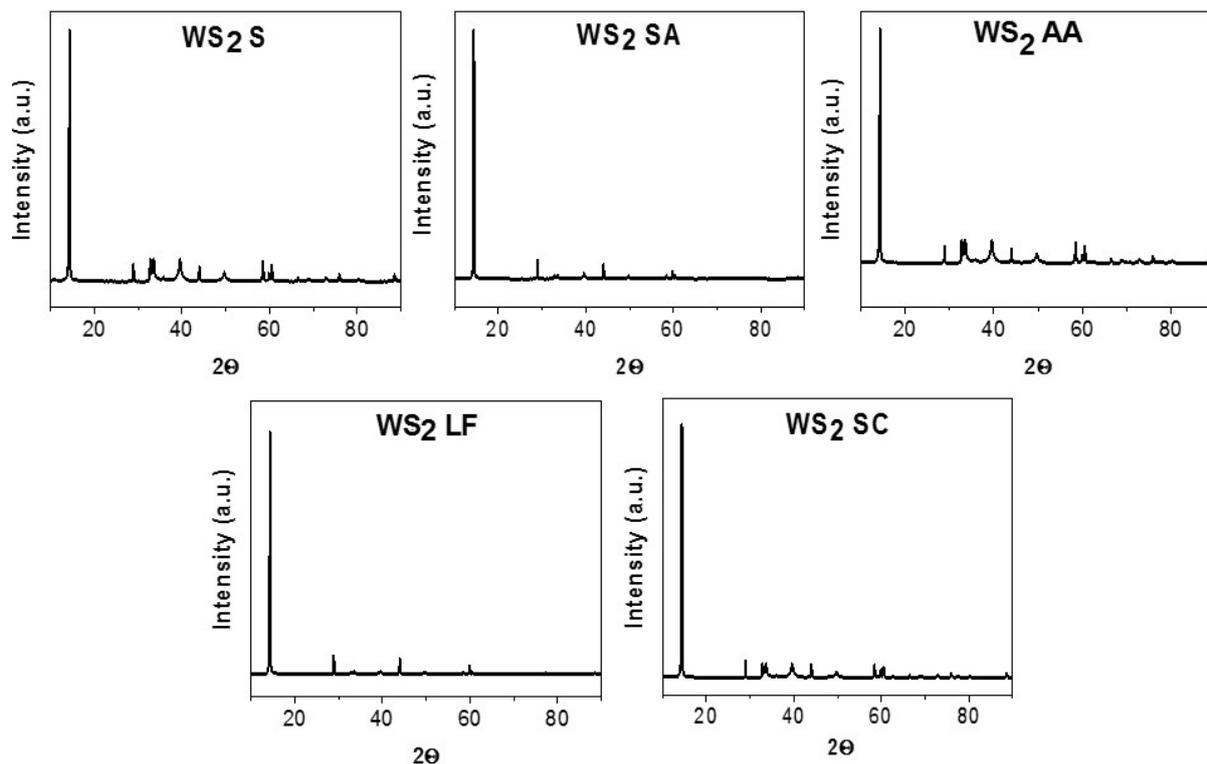
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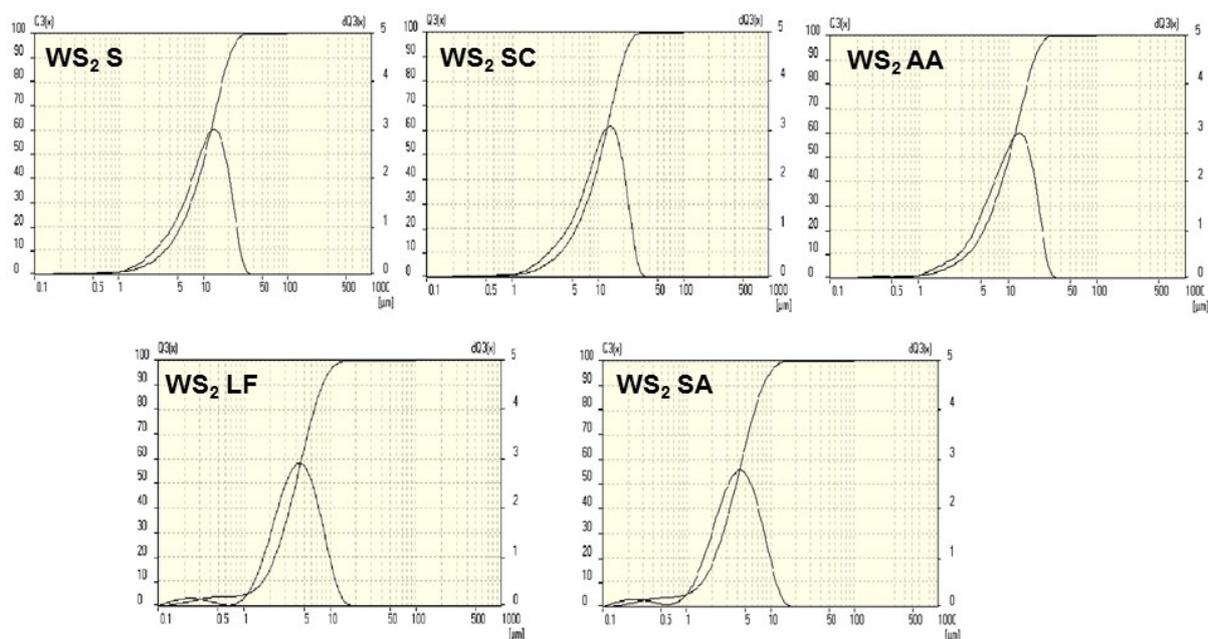
**Figure S1.** SEM micrographs and EDS maps of elemental distribution of WS<sub>2</sub> samples obtained from different suppliers.

**Table S1.** The results of X-ray fluorescence (XRF) analysis of WS<sub>2</sub> from different suppliers.

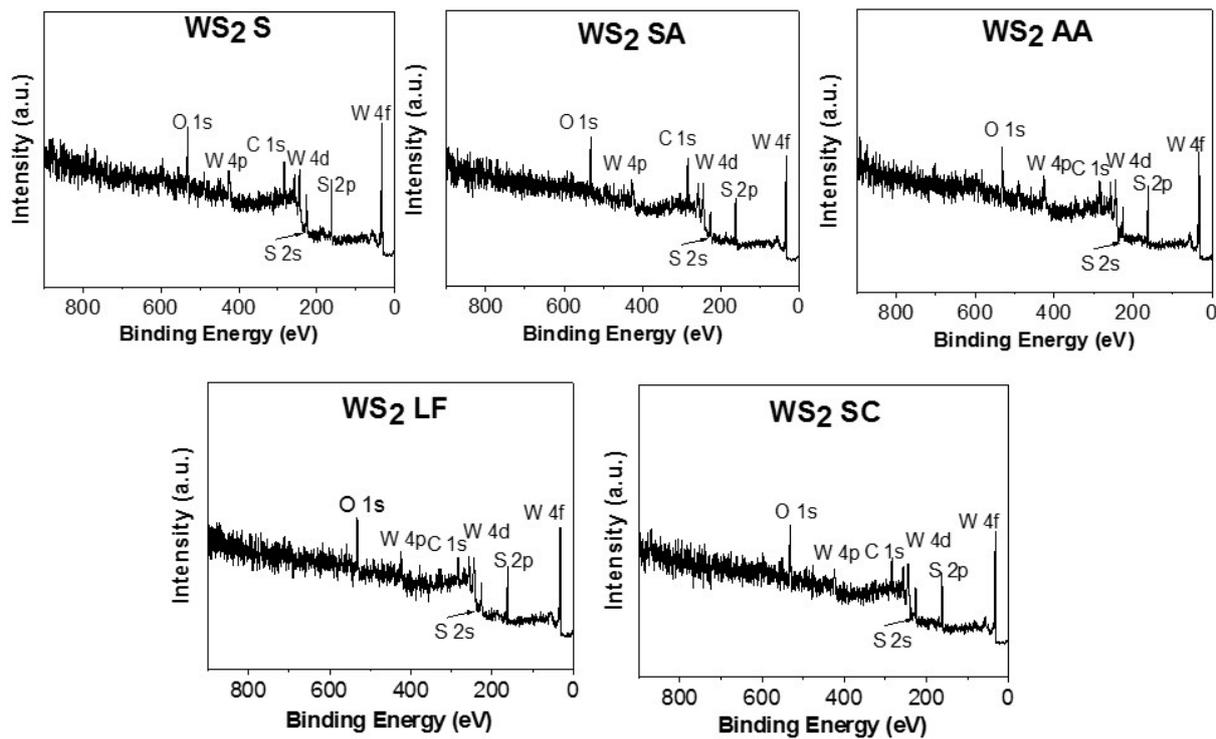
Sample	W (wt.%)	S (wt.%)	V (ppm)	Fe (ppm)	K (ppm)	Y (ppm)
WS <sub>2</sub> S	72.19	27.80				
WS <sub>2</sub> SA	71.82	28.16		90		
WS <sub>2</sub> AA	71.85	28.13				45
WS <sub>2</sub> LF	72.26	27.67		54		
WS <sub>2</sub> SC	72.03	27.95	44	38		



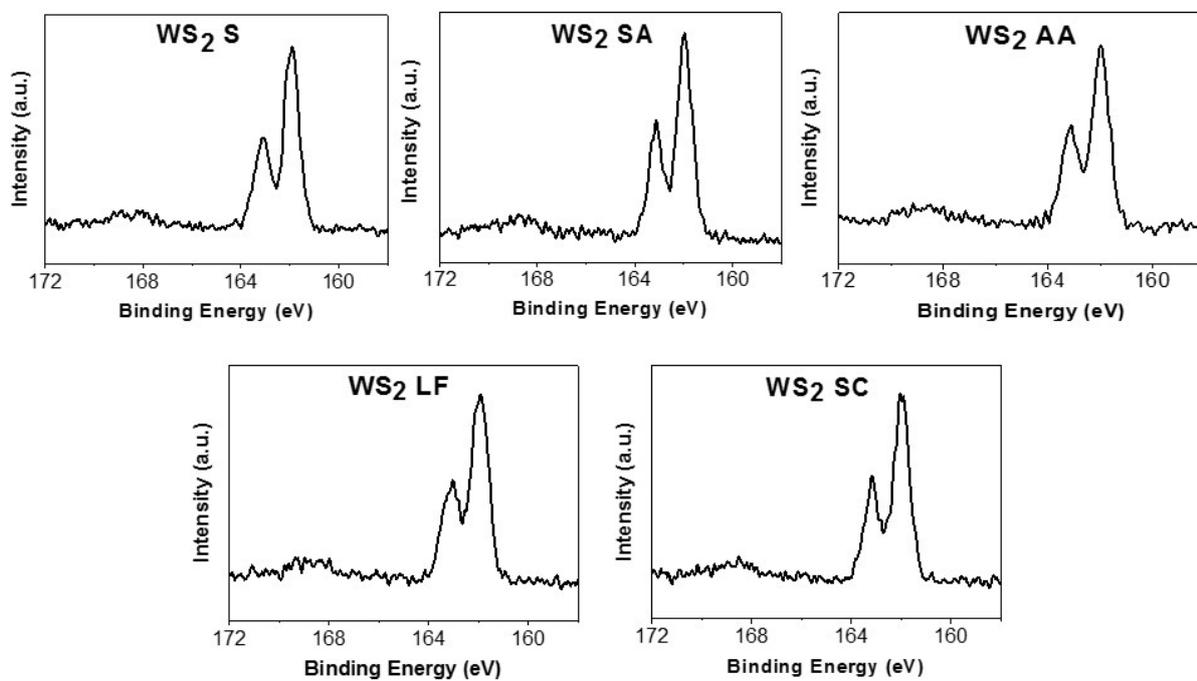
**Figure S2.** XRD diffractograms of various  $WS_2$  samples. Small lines in the bottom part represent reference data taken from PDF database (PDF# 04-004-0730).



**Figure S3.** Particle size distribution of  $WS_2$  obtained from different suppliers.



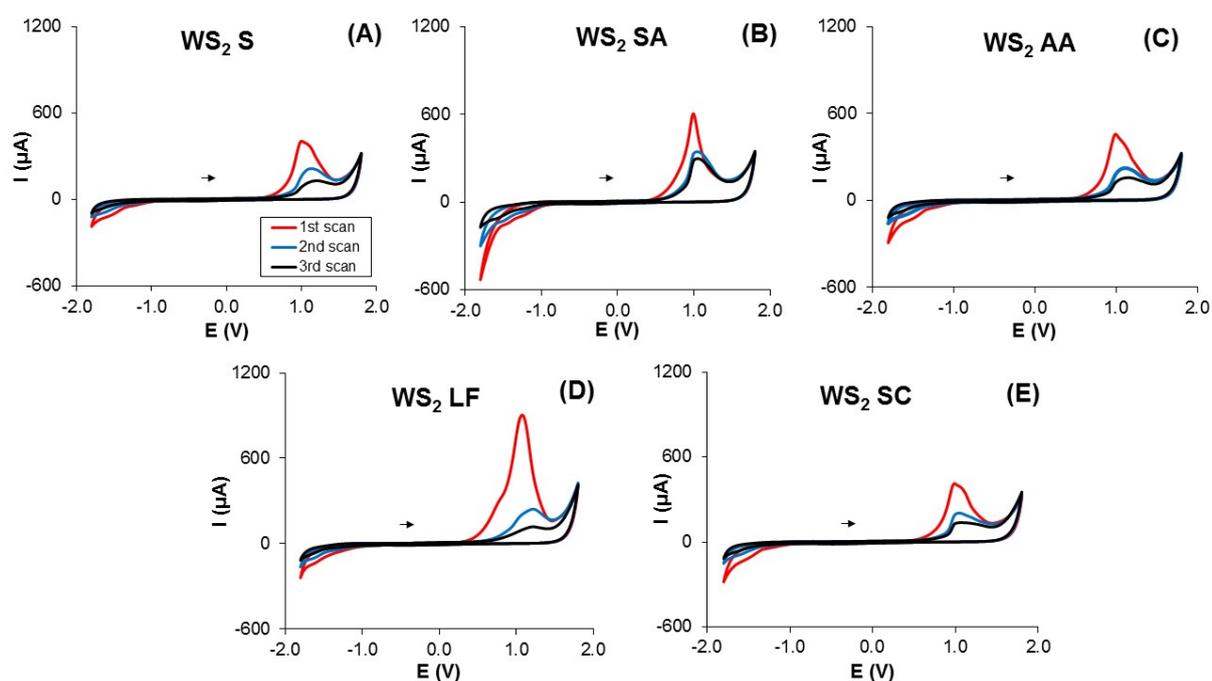
**Figure S4.** Survey spectra of WS<sub>2</sub> from different suppliers.



**Figure S5.** High resolution XPS spectra of S 2p peak performed on WS<sub>2</sub> from different suppliers.

**Table S2.** Respective concentrations of  $W^{4+}$  and  $W^{6+}$ .

Sample	$W^{4+}$ (at. %)	$W^{6+}$ (at. %)
<b>WS<sub>2</sub> S</b>	84.0	16.0
<b>WS<sub>2</sub> SA</b>	89.2	10.8
<b>WS<sub>2</sub> AA</b>	88.0	12.0
<b>WS<sub>2</sub> LF</b>	85.1	14.9
<b>WS<sub>2</sub> SC</b>	83.3	16.7



**Figure S6.** (A)-(E) Cyclic voltammograms illustrating inherent electrochemistry of bulk tungsten TMD materials from different providers, subject to 10 minutes of sonication. The first three scans are shown for comparison. All scans start at 0.0 V vs. Ag/AgCl and arrows indicate the starting scan direction. Conditions: 50 mM phosphate buffered saline (PBS) at pH 7.20 as supporting electrolyte; scan rate:  $100 \text{ mV s}^{-1}$

**Table S3.** Peak positions and current intensities of the single oxidative peaks of all five WS<sub>2</sub> materials, subject to different durations of sonication.

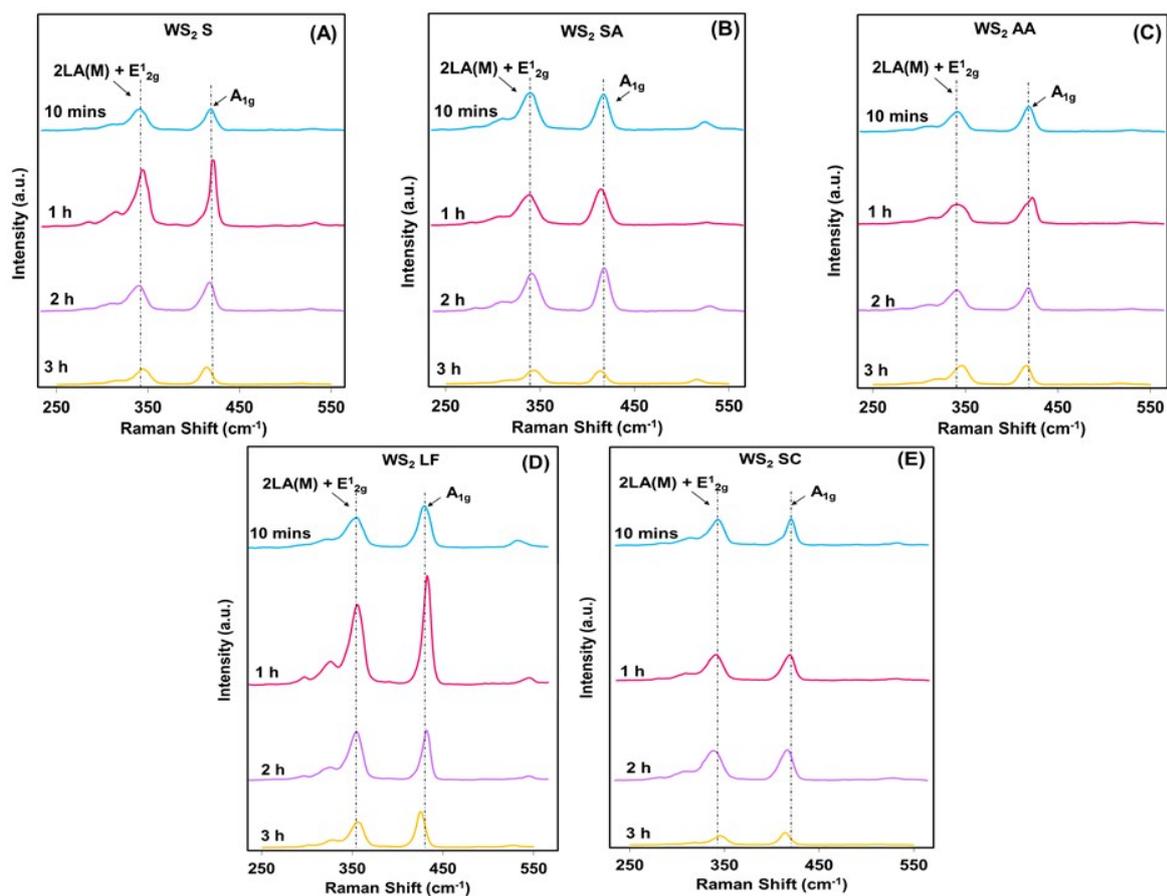
		Sonication		Material		
		Time		WS <sub>2</sub> S	WS <sub>2</sub> SA	WS <sub>2</sub> AA
Peak Position (V) vs. Ag/AgCl	10 mins	0.966	0.991	0.994	1.074	0.984
	1 h	0.972	1.07	1.03	1.09	0.994
	2 h	1.03	1.01	0.972	1.07	0.989
	3 h	1.02	0.957	0.967	0.952	0.962
Current Intensity (μA)	10 mins	329.25	520.90	381.60	793.87	337.08
	1 h	236.95	895.80	482.89	936.41	391.96
	2 h	468.43	555.59	253.34	638.30	425.66
	3 h	25.46	111.03	151.18	96.70	140.65

**Table S4.** Calculated HET rate constants for all five bulk WS<sub>2</sub> materials. The rate constant of bare GC electrodes are included for reference.

		Sonication		Material			
		Time		WS <sub>2</sub> S	WS <sub>2</sub> SA	WS <sub>2</sub> AA	WS <sub>2</sub> LF
$k_{obs}^o$ (cm s <sup>-1</sup> )	10 mins	4.12 *	3.94 *	4.26 *	2.96 *	3.99 *	
		10 <sup>-3</sup>	10 <sup>-3</sup>	10 <sup>-3</sup>	10 <sup>-3</sup>	10 <sup>-3</sup>	
	1 h	2.43*	4.03 *	4.17 *	3.20 *	4.21 *	2.89 *
		10 <sup>-3</sup>	10 <sup>-3</sup>	10 <sup>-3</sup>	10 <sup>-3</sup>	10 <sup>-3</sup>	10 <sup>-3</sup>
	2 h	3.06 *	4.03 *	4.08 *	2.68 *	3.77 *	
		10 <sup>-3</sup>	10 <sup>-3</sup>	10 <sup>-3</sup>	10 <sup>-3</sup>	10 <sup>-3</sup>	
	3 h	3.49 *	3.82 *	3.86 *	3.42 *	3.82 *	
		10 <sup>-3</sup>	10 <sup>-3</sup>	10 <sup>-3</sup>	10 <sup>-3</sup>	10 <sup>-3</sup>	

**Table S5.** Average particle size for different periods of sonication measured by dynamic light scattering (DLS).

Sample	10 min (nm)	1h (nm)	2h (nm)	3h (nm)
WS <sub>2</sub> S	5702	1692	1804	2471
WS <sub>2</sub> SA	2443	2616	2163	2044
WS <sub>2</sub> AA	2403	1645	1367	3180
WS <sub>2</sub> LF	2013	1900	2358	1118
WS <sub>2</sub> SC	2035	2730	2328	2953



**Figure S7.** Raman spectra of WS<sub>2</sub> samples from different providers subject to different sonication times.

**Table S6.**  $E_{2g}^1(\Gamma)$  and  $A_{1g}(\Gamma)$  peak signals from Raman spectra of  $WS_2$  samples from different providers subject to different sonication times.

	Raman Shift ( $cm^{-1}$ )							
	Sonication time							
	10 mins		1 h		2 h		3 h	
	$E_{2g}^1(\Gamma)$	$A_{1g}(\Gamma)$	$E_{2g}^1(\Gamma)$	$A_{1g}(\Gamma)$	$E_{2g}^1(\Gamma)$	$A_{1g}(\Gamma)$	$E_{2g}^1(\Gamma)$	$A_{1g}(\Gamma)$
<b><math>WS_2</math> S</b>	346.51	418.60	348.84	418.60	346.51	416.28	344.19	413.95
<b><math>WS_2</math> SA</b>	346.51	416.28	344.19	413.95	344.19	413.95	344.19	413.95
<b><math>WS_2</math> AA</b>	346.51	416.28	348.84	420.93	346.51	416.28	346.51	416.28
<b><math>WS_2</math> LF</b>	359.13	426.22	359.13	428.53	356.81	428.53	356.81	426.22
<b><math>WS_2</math> SC</b>	348.84	418.60	346.51	416.28	344.19	416.28	346.51	413.95