Fig. 2. (a) Nitrogen adsorption/desorption isotherms realized at -196 °C, (b) Pore size distribution (PSD) using the 2D-NLDFT model of H_3PO_4-impregnated WS based ACs P-400, P-500, P-800 and P-400-M.

Table 1
Textural parameters of ACs prepared from WS by chemical activation with H_3PO_4

#	Material	S_{BET} ($m^2 \cdot g^{-1}$)	S_{DFT} ($m^2 \cdot g^{-1}$)	V_{micro} ($cm^3 \cdot g^{-1}$)	V_{meso} ($cm^3 \cdot g^{-1}$)	Average micropores size (nm)
1	P-400	2095	1621	0.52	0.73	1.13
2	P-500	1987	1536	0.46	0.72	1.01
3	P-800	1956	1578	0.67	0.32	0.76
4	P-400-M	2055	1789	0.58	0.88	0.86

Table 2
Specific surface area (BET) calculated for WS-based carbons

#	Precursor	Activator	Specific surface area (BET)	Source
1	Walnut shell	CO_2	697 $m^2 \cdot g^{-1}$	[16]
2	Walnut shell	$ZnCl_2$	1452 $m^2 \cdot g^{-1}$	[17]
3	Walnut shell	KOH	2044 $m^2 \cdot g^{-1}$	[18]
4	Walnut shell	H_3PO_4	2095 $m^2 g^{-1}$	Present work

The following Table 2 briefly summarizes BET specific surface area typical for carbons based on WS activated by various oxidizing agents, such as zinc chloride, potassium hydroxide or gaseous carbon dioxide. One can see that the value of specific surface area calculated for P-400 is higher than that of all the carbons represented in Table 2.

The CVs and GCPL curves for AC/AC cells with prepared carbons up to 1.0 V in 1 mol L^{-1} Li_2SO_4 are presented in Fig. 3(a) and (b) respectively. CV for P-400 is characterized by poor capacitive traces and the further rising of activation temperature up to 500 °C does not change much the charging characteristics. Even for the carbon activated at 800 °C, the CV shape is not rectangular suggesting the hindrance to ionic movement inside the porosity. However, implementing P-400-M resulted in quasi-perfect shape of CV. In such a carbon, the porous structure reorganization due to post-treatment facilitates the movement of ions within porosity. Similarly, the rectangular CV and symmetric GCPL for cell using P-400-M shows the absence of faradaic contributions owing to loss of oxygenated functionalities giving rise to highly accessible porosity. Nyquist plots in Fig. 3(c) reveal a shift in charge transfer resistance (R_{ct}) from 4.4 (P-400) to 1.6 Ω (P-400-M) and the former demonstrates low ESR (0.4 Ω). However, improved R_{ct} values for P-400-M indicate significant modification in the porous structure leading to facile diffusion of electrolyte. Moreover, the cell using P-400-M demonstrates higher capacitance than cell using DLC Supra 30 (Fig. 3(d)).

Further, AC/AC cell using P-400-M electrodes and 1 mol L^{-1} Li_2SO_4 polarized up to 1.5 V demonstrates nearly rectangular CVs and symmetric GCPL curves at 0.2 A g^{-1}. Furthermore, this cell exhibits a capacitance of 123 F g^{-1} (0.2 A g^{-1}) and constant capacitance at 1.0 A.g^{-1} for 5000 galvanostatic charge/discharge showing a good state-of-health during long-term cycling.