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Functionalized 2D materials in solid-state electrolyte for flexible supercapacitors

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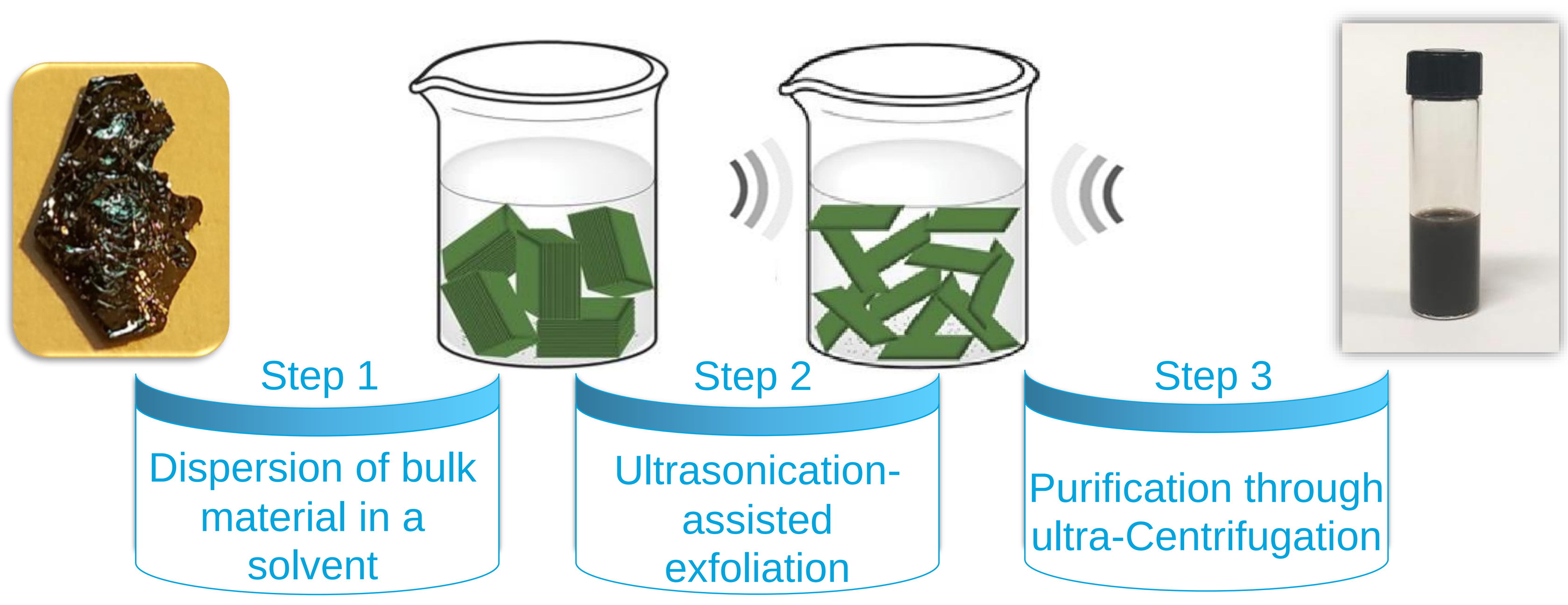
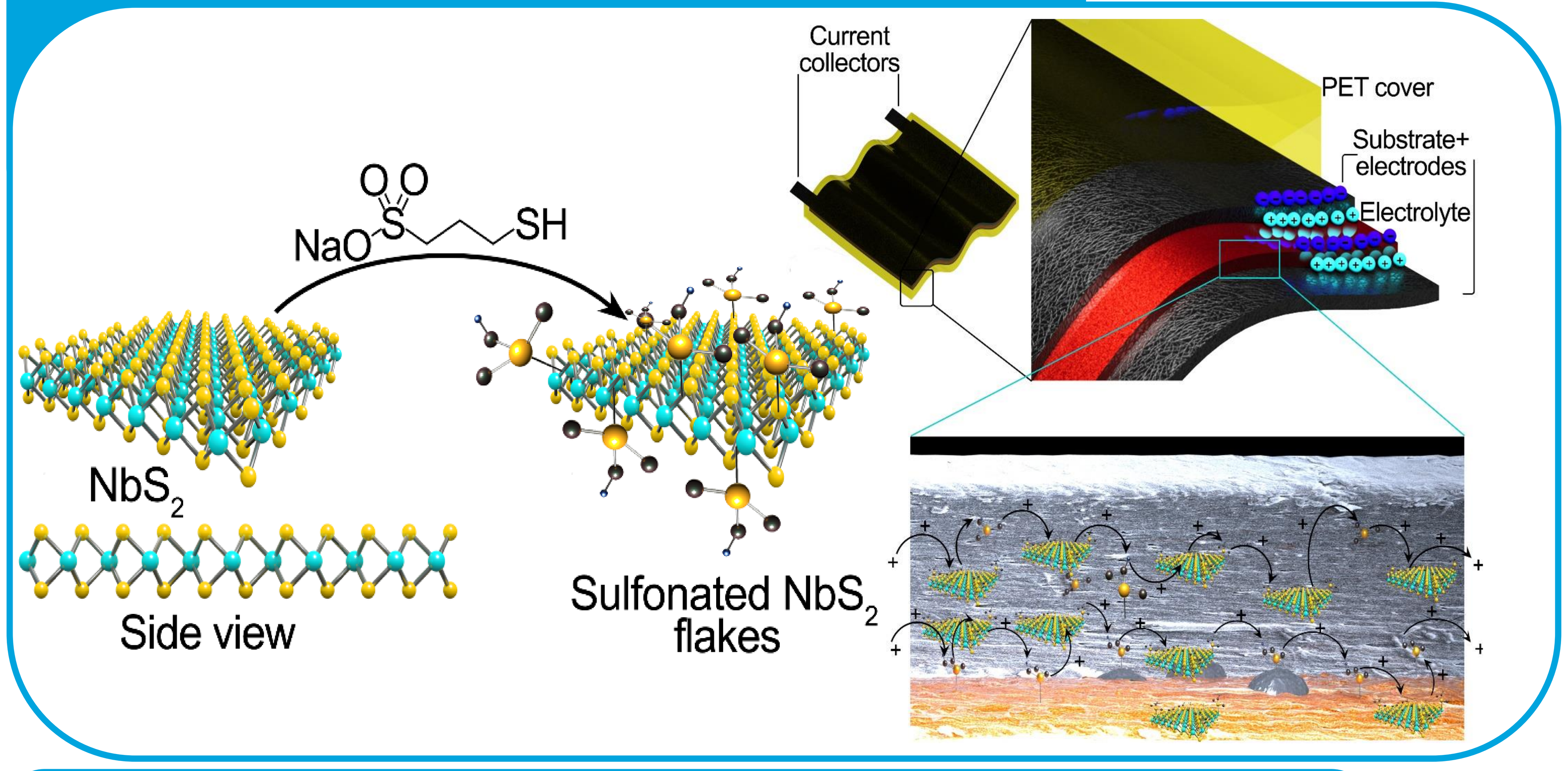
INTRODUCTION

Solid-state flexible supercapacitors (SSFSs) have drawn an increasingly attention due to their special mechanical features (*e.g.*, foldability) accompanied by high power density (*i.e.*, fast charge-discharge rate) [1]. Therefore, SSFSs represent appropriate candidates for powering portable electronic devices, including wearable power-supply units [2]. Moreover, SSFSs intrinsically overcome the electrolyte leakage of traditional supercapacitors, eliminating safety and environmental concerns without requiring rigid and robust packaging strategies [3]. However, solid-state electrolytes still suffer from poor ion mobility and reactivity that undermine the practical use of these devices [4]. To address these issues, the incorporation of transition metal dichalcogenides (TMDCs), *i.e.*, sulfonated 2D niobium disulphide (S-NbS_2), in proton-conducting sulfonated poly(ether ether ketone) (SPEEK) was investigated as solid-state electrolyte for high-power SSFSs.

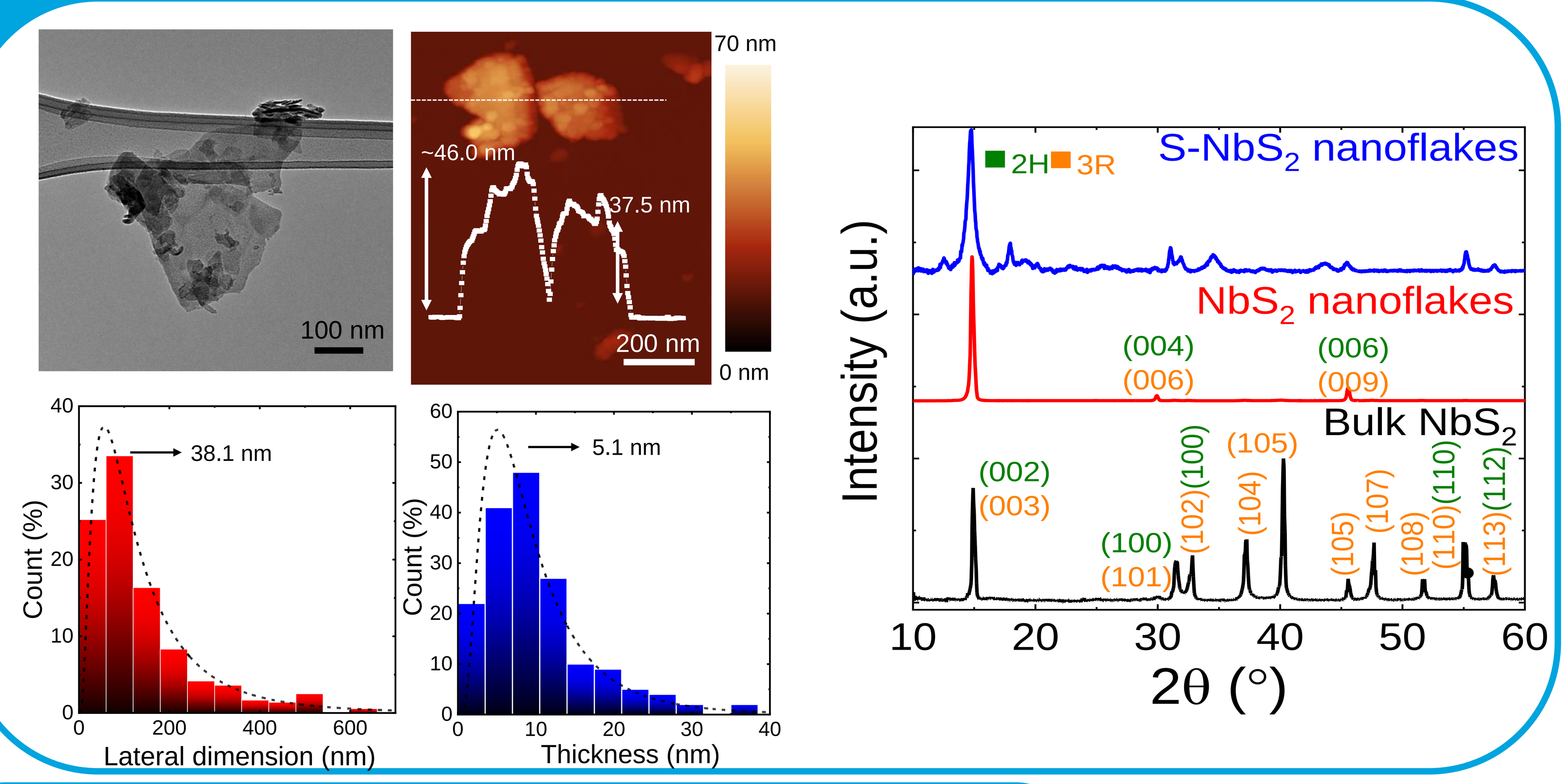
LIQUID PHASE EXFOLIATION (LPE)



FUNCTIONALIZATION PROCESS



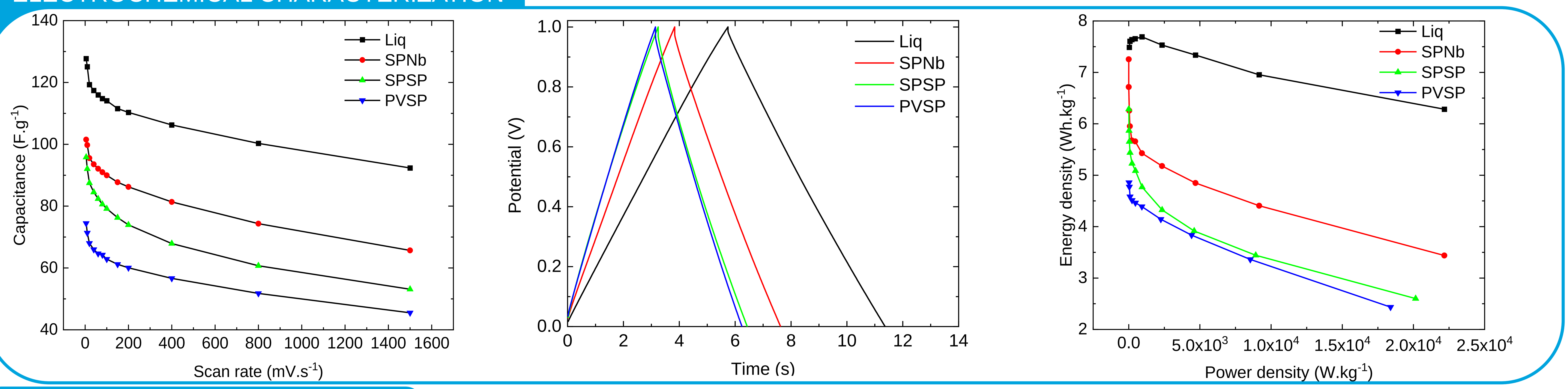
MORPHOLOGICAL CHARACTERIZATION



ELECTRODE AND SOLID ELECTROLYTE PREPARATION

Electrolyte	Binder	Acronym	R_s	R_2	R_{ct}	mechanical strength (MP)
1M H_2SO_4 solution	SPEEK	Liq	0.291	0.506	0.215	-
SPEEK/f-NbS_2	SPEEK	SP-fNbS_2	0.556	0.835	0.279	38.3
SPEEK	SPEEK	SP-SP	0.568	0.912	0.343	36.4
SPEEK	pvdf	PV-SP	0.601	1.099	0.498	36.4

ELECTROCHEMICAL CHARACTERIZATION



CONCLUSIONS

The incorporation of functionalized 2D materials into polymeric matrix led to a maximum proton conductivity of 94.35 mS cm^{-2} at room temperature, coupled with an improvement of 18% of the mechanical strength compared to pristine SPEEK (up to 38.3 MPa). Our results rationalize the use of S-NbS_2 as additive for solid-state electrolytes, promoting the development of high power SSFSs..

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