Electronic Supplementary Material (ESI) for Journal of Materials Chemistry A.

Supplementary Information for

Mechanochemical synthesis of fast sodium ion conductor $Na_{11}Sn_2PSe_{12}$ enables first sodium-selenium all-solid-state battery

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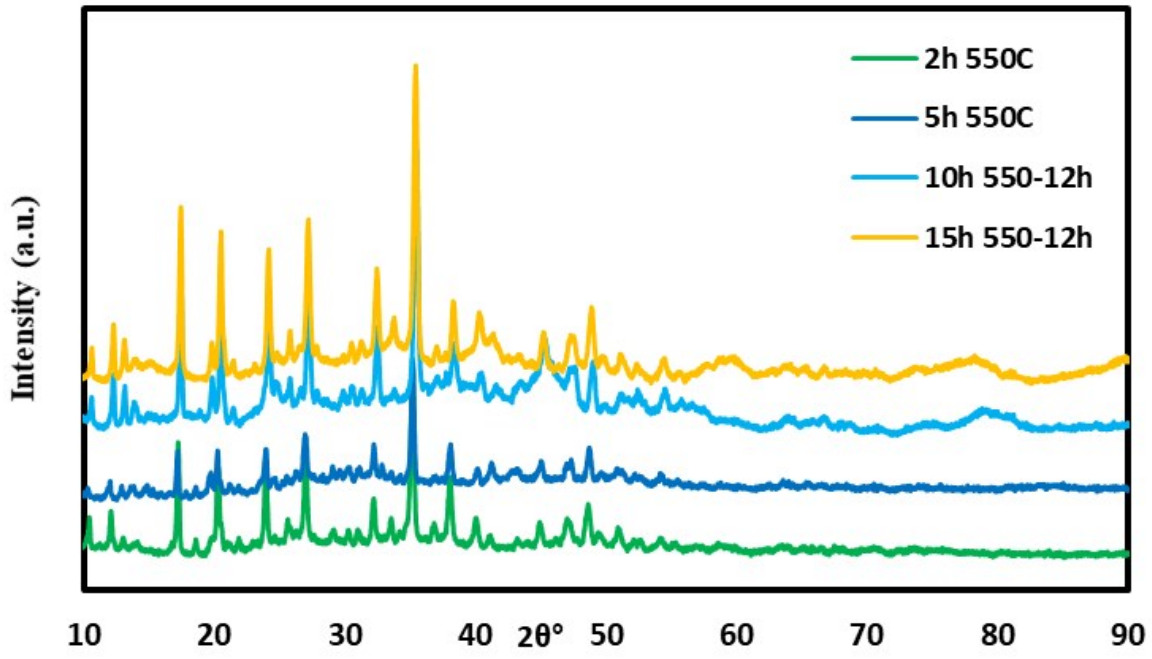

Figure S1. XRD data of ball milled samples for various number of hours followed by annealing at 550C for 6 h (for 2h and 5h ball milled samples) and 12h for samples ball milled for 10h and 15h.

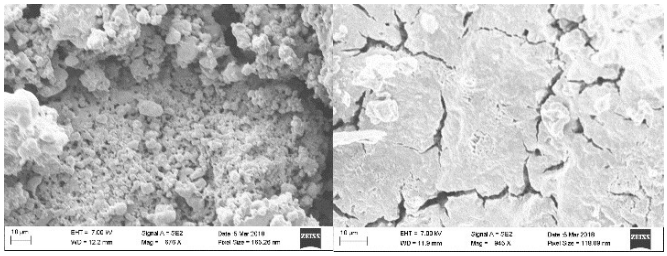

Figure S2. SEM image of $Na_{11}Sn_2PSe_{12}$ (i) ball milled for 15 h (ii) ball milled for 15h followed by annealing at 550 ^{o}C for 6h.

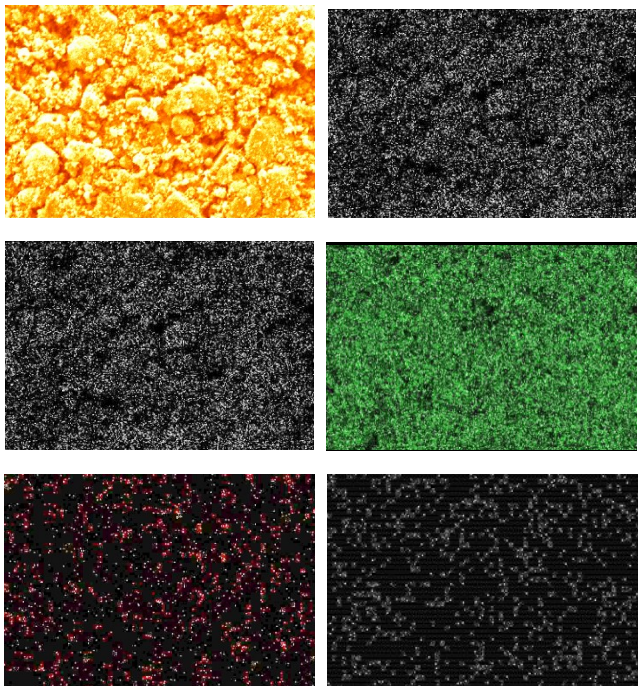

Figure S3. EDX elemental mapping of C-Se-S.E. composite electrode after ball milling for 30 minutes. The figures are SEM image (top left), elements C (top right), Sn (middle left), Na (middle right), Se (bottom left), and P (bottom right). The uniform distribution in the maps confirms a homogeneous distribution of the elements in the composite cathode.

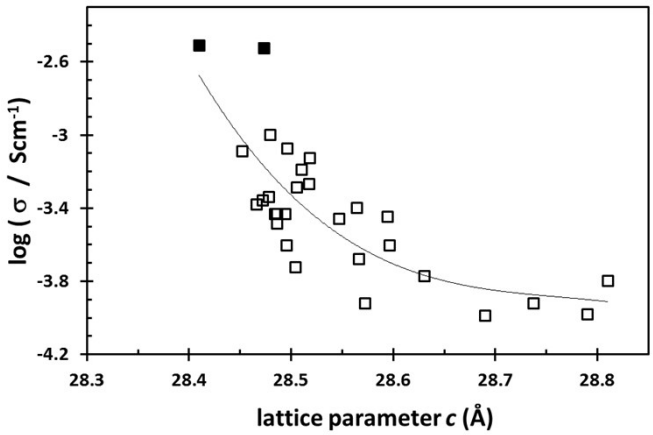

Figure S4. Correlation between the room temperature conductivity and the lattice parameter *c* for the mechanochemically synthesized samples in this work (open squares) as well as for single crystal data from Duchardt et al.[1] and Yu et al.[2] (filled symbols). The solid line represents a polynomial fit as a guide to the eye.

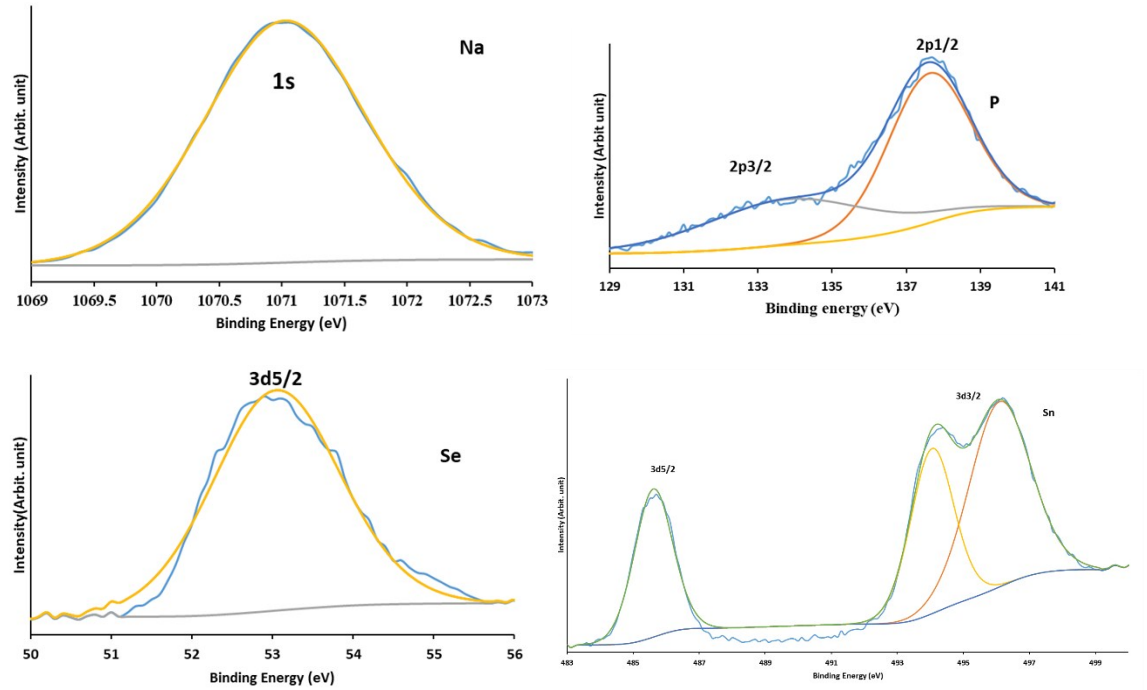

Figure S5. XPS data of samples ball milled for 10h followed by annealing at 600 ^{o}C.

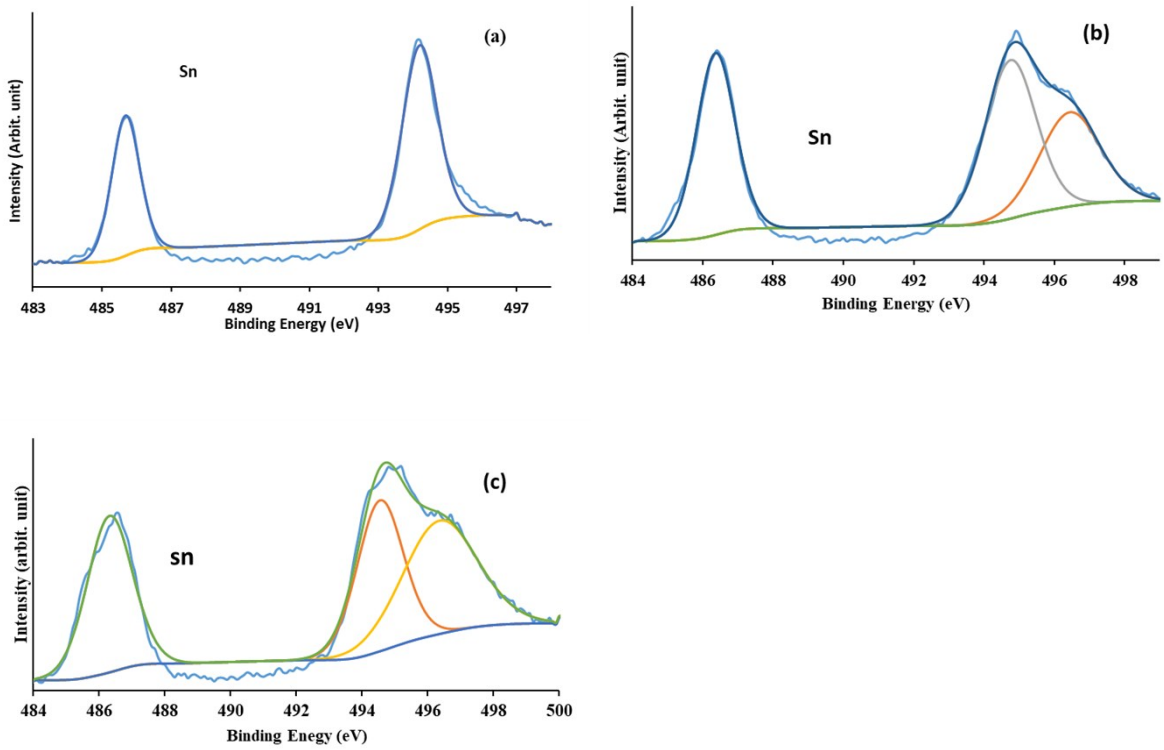

Figure S6. XPS data of Sn element for samples (a) 2h ball milled for 2h (b) 10h ball milled followed by annealing at 500 ^{o} for 6h (c) 2 h ball milled followed by annealing 550 ^{o}C for 18h.

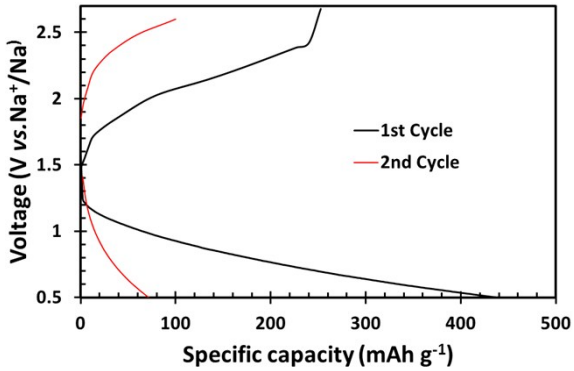

Figure S7. Charge discharge studies of Na/$Na_{11}Sn_2PSe_{12}$/C-Se battery.

References

1 M. Duchardt, S. Neuberger, U. Ruschewitz, T. Krauskopf, W.G. Zeier, J. Schmedt auf der Günne, S. Adams, B. Roling and S. Dehnen, *Chem. Mater.* 2018, 30, 4134-4139.

2 Z. Yu, S.L. Shang, D. Wang, Y.C. Li, H.P. Yennawar, G. Li, H.T. Huang, Y. Gao, T.E. Mallouk, Z.K. Liu and D. Wang, *Energy Storage Materials* 2019, 217, 70–77.