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Fabrication and characterization of printed zinc batteries

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Abstract

Author keywords

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Abstract

Zinc batteries are a more sustainable alternative to lithium-ion batteries due to its components being highly recyclable. With the improvements in the screen printing technology, high quality devices can be printed with at high throughput and precision at a lower cost compared to those manufactured using lithographic techniques. In this paper we describe the fabrication and characterization of printed zinc batteries . Different binder materials such as polyvinyl pyrrolidone (PVP) and polyvinyl butyral (PVB), were used to fabricate the electrodes. The electrodes were first evaluated using threeelectrode cyclic voltammetry, x-ray diffraction (XRD), and scanning electron microscopy before being fully assembled and tested using charge-discharge test and two-electrode cyclic voltammetry. The results show that the printed ZnO electrode with PVB as binder performed better than PVP-based ZnO. The XRD data prove that the electro-active materials were successfully transferred to the sample. However, based on the evaluation, the results show that the cathode electrode was dominated by the silver instead of Ni(OH)2, which leads the sample to behave like a silver- zinc battery instead of a nickel- zinc battery . Nevertheless, the printed zinc battery electrodes were successfully evaluated, and more current collector materials for cathode should be explored for printed nickel- zinc batteries .

Author keywords

Cyclic voltammetry; Polyvinyl butyral; Printed zinc batteries ; Screen printing; X-ray diffraction

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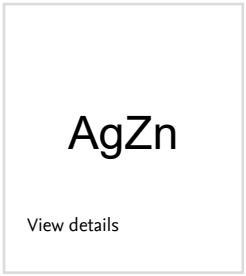

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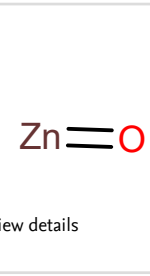

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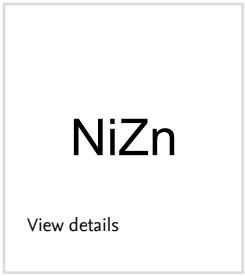

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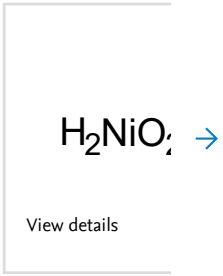

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References (26)

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1 He, X.
(2015) *Printed and Thin Film Batteries 2015-2025: Technologies, Forecasts, Players*. Cited 3 times.
Flexible, IDTechEx Ltd

2 Nguyen, D.T., Taguchi, K.
A water-activated battery based on activated carbon
(Open Access)

(2019) *International Journal of Electrical and Computer Engineering*, 9 (5), pp. 4053-4059. Cited 4 times.
http://ijece.iaescore.com/index.php/IJECE/article/view/16738/13006
doi: 10.11591/ijece.v9i5.pp4053-4059

View at Publisher

3 Rajanna, B.V., Kumar, M.K.
Dynamic model development for lead acid storage battery
(Open Access)

(2019) *Indonesian Journal of Electrical Engineering and Computer Science*, 15 (2), pp. 609-619. Cited 13 times.
http://ijeecs.iaescore.com/index.php/IJEECS
doi: 10.11591/ijeecs.v15.i2.pp609-619

View at Publisher

4 Soeprapto, Hasanah, R.N., Taufik

Battery management system on electric bike using lithium-ion 18650

(2019) *International Journal of Power Electronics and Drive Systems*, 10 (3), pp. 1529-1537. Cited 6 times.
http://ijpeds.iaescore.com/index.php/IJPEDS/article/download/19854/12878
doi: 10.11591/ijpeds.v10.i3.1529-1537

View at Publisher

5 Duraisamy, T., Kaliyaperumal, D.

Active cell balancing for electric vehicle battery management system (Open Access)

(2020) *International Journal of Power Electronics and Drive Systems*, 11 (2), pp. 571-579. Cited 6 times.
http://ijpeds.iaescore.com/index.php/IJPEDS/article/download/20414/13062
doi: 10.11591/ijpeds.v11.i2.pp571-579

View at Publisher

6 Boujoudar, Y., Elmoussaoui, H., Lamhamdi, T.

Lithium-ion batteries modeling and state of charge estimation using artificial neural network (Open Access)

(2019) *International Journal of Electrical and Computer Engineering*, 9 (5), pp. 3415-3422. Cited 5 times.
http://ijece.iaescore.com/index.php/IJECE/article/view/15552/12932
doi: 10.11591/ijece.v9i5.pp3415-3422

View at Publisher

7 Rajanna, B.V., Kumar, M.K.

Comparison of one and two time constant models for lithium ion battery (Open Access)

(2020) *International Journal of Electrical and Computer Engineering*, 10 (1), pp. 670-680. Cited 7 times.
http://ijece.iaescore.com/index.php/IJECE/article/view/20632/pdf
doi: 10.11591/ijece.v10i1.pp670-680

View at Publisher

8 Xu, K.

Nonaqueous liquid electrolytes for lithium-based rechargeable batteries

(2004) *Chemical Reviews*, 104 (10), pp. 4303-4417. Cited 4031 times.
doi: 10.1021/cr030203g

View at Publisher

9 Couzis, A., Feinstein, J.

Zinc anode battery rechargeable technology

(2014) *2014 IEEE NewNEB DC Utility Power Conference and Exhibition, NewNEB 2015*, art. no. 7351781.
ISBN: 978-147994064-6
doi: 10.1109/NewNEB.2014.7351781

View at Publisher

10 Shin, J., You, J.-M., Lee, J.Z., Kumar, R., Yin, L., Wang, J., Shirley Meng, Y.

Deposition of ZnO on bismuth species towards a rechargeable Zn-based aqueous battery

(2016) *Physical Chemistry Chemical Physics*, 18 (38), pp. 26376-26382. Cited 26 times.
http://www.rsc.org/Publishing/Journals/CP/index.asp
doi: 10.1039/c6cp04566a

View at Publisher

11 Gaikwad, A.M., Arias, A.C., Steingart, D.A.

Recent Progress on Printed Flexible Batteries: Mechanical Challenges, Printing Technologies, and Future Prospects

(2014) *Energy Technology*, 3 (4), pp. 305-328. Cited 99 times.
http://onlinelibrary.wiley.com.ezlib.iium.edu.my/journal/10.1002/(ISSN)2194-4296
doi: 10.1002/ente.201402182

View at Publisher

12 Yan, C., Wang, X., Cui, M., Wang, J., Kang, W., Foo, C.Y., Lee, P.S.

Stretchable silver-zinc batteries based on embedded nanowire elastic conductors

(2014) *Advanced Energy Materials*, 4 (5), art. no. 1301396. Cited 97 times.
http://www.wiley-vch.de/publish/dt/journals/newJournals/2528/?sID=jb1vjpnlg2gcbb145lgmejvlb2
doi: 10.1002/aenm.201301396

View at Publisher

13 Kumar, R., Shin, J., Yin, L., You, J.-M., Meng, Y.S., Wang, J.

All-Printed, Stretchable Zn-Ag_2O Rechargeable Battery via Hyperelastic Binder for Self-Powering Wearable Electronics (Open Access)

(2017) *Advanced Energy Materials*, 7 (8). Cited 121 times.
http://onlinelibrary.wiley.com.ezlib.iium.edu.my/journal/10.1002/(ISSN)1614-6840
doi: 10.1002/aenm.201602096

View at Publisher

14 Huebner, G., Krebs, M.

Printed, flexible thin-film-batteries and other power storage devices

(2015) *Handbook of Flexible Organic Electronics: Materials, Manufacturing and Applications*, pp. 429-447. Cited 5 times.
http://www.sciencedirect.com.ezlib.iium.edu.my/science/book/9781782420354
ISBN: 978-178242043-9; 978-178242035-4
doi: 10.1016/B978-1-78242-035-4.00018-X

View at Publisher

15 Kheawhom, S., Suren, S.
Printed air cathode for flexible and high energy density zinc-air battery
(2016) *MRS Adv*, pp. 1-7.
July

16 Tehrani, Z., Korochkina, T., Govindarajan, S., Thomas, D.J., O'Mahony, J., Kettle, J., Claypole, T.C., (...), Gethin, D.T.

Ultra-thin flexible screen printed rechargeable polymer battery for wearable electronic applications

(2015) *Organic Electronics*, 26, art. no. 3229, pp. 386-394. Cited 49 times.
www.elsevier.com/locate/orgel
doi: 10.1016/j.orgel.2015.08.007

View at Publisher

17 Reddy, T., Linden, D.
(2015) *Lindens Handbook of Batteries 4th Edition*. Cited 59 times.
4th ed. New York: McGraw-Hill New York

18 Zamarayeva, A.M., Gaikwad, A.M., Deckman, I., Wang, M., Khau, B., Steingart, D.A., Arias, A.C.

Fabrication of a High-Performance Flexible Silver–Zinc Wire Battery (Open Access)

(2016) *Advanced Electronic Materials*, 2 (5), art. no. 1500296. Cited 42 times.
http://onlinelibrary.wiley.com.ezlib.iium.edu.my/journal/10.1002/(ISSN)2199-160X
doi: 10.1002/aelm.201500296

View at Publisher

19 Lai, S.-B., Jamesh, M.-I., Wu, X.-C., Dong, Y.-L., Wang, J.-H., Gao, M., Liu, J.-F., (...), Sun, X.-M.

A promising energy storage system: rechargeable Ni–Zn battery

(2017) *Rare Metals*, 36 (5), pp. 381-396. Cited 32 times.
http://www.springer.com.ezlib.iium.edu.my/materials/special+types/journal/12598
doi: 10.1007/s12598-017-0905-x

View at Publisher

20 Periasamy, P., Tatsumi, K., Shikano, M., Fujieda, T., Saito, Y., Sakai, T., Mizuhata, M., (...), Deki, S.

Studies on PVdF-based gel polymer electrolytes

(2000) *Journal of Power Sources*, 88 (2), pp. 269-273. Cited 59 times.
doi: 10.1016/S0378-7753(99)00348-1

View at Publisher

21 Liu, J., Guan, C., Zhou, C., Fan, Z., Ke, Q., Zhang, G., Liu, C., (...), Wang, J.

A Flexible Quasi-Solid-State Nickel–Zinc Battery with High Energy and Power Densities Based on 3D Electrode Design

(2016) *Advanced Materials*, 28 (39), pp. 8732-8739. Cited 302 times.
http://www3.interscience.wiley.com.ezlib.iium.edu.my/journal/119030556/issue
doi: 10.1002/adma.201603038

View at Publisher

22 Linden, D., Reddy, T. B.
(2001) *Handbook of Batteries*. Cited 2975 times.
3rd ed. New York: McGraw-Hill

23 Hobby, A.
(1997) *Gwent Group*
The Gwent Group, Leaders in paste manufacturing, sensor biosensor development and Instrumentation, [Online]. Available: [Accessed: 06-Dec-2019]
http://www.gwent.org/gem_screen_printing.html

24 Elgrishi, N., Rountree, K.J., McCarthy, B.D., Rountree, E.S., Eisenhart, T.T., Dempsey, J.L.
A Practical Beginner's Guide to Cyclic Voltammetry
(Open Access)

(2018) *Journal of Chemical Education*, 95 (2), pp. 197-206. Cited 598 times.
http://pubs.acs.org.ezlib.iium.edu.my/loi/jceda8
doi: 10.1021/acs.jchemed.7b00361

View at Publisher

25 Renuka, R., Srinivasan, L., Ramamurthy, S., Veluchamy, A., Venkatakrishnan, N.
Cyclic voltammetric study of zinc and zinc oxide electrodes in 5.3 M KOH

(2001) *Journal of Applied Electrochemistry*, 31 (6), pp. 655-661. Cited 33 times.
doi: 10.1023/A:1017562514934

View at Publisher

26 Yunchang, D., Jiongliang, Y., Zhaorong, C.
Cyclic voltammetry response of coprecipitated Ni $(OH)_2$ electrode in 5 M KOH solution

(1997) *Journal of Power Sources*, 69 (1-2), pp. 47-54. Cited 24 times.
https://www.journals.elsevier.com/journal-of-power-sources
doi: 10.1016/s0378-7753(97)02565-2

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