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The electrical, dielectric and magnetic effect of $MgFe_2O_4$–polypyrrole and its composites

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Abstract

In the modern world of health and life sciences, the utilization of nanoscale materials, particularly magnetic nanoparticles, is a hot topic. Here in the present study, $MgFe_2O_4$ is synthesized via the chemical co-precipitation technique, and the polypyrrole (PPy) is fabricated via in situ polymerization technique to form the $MgFe_2O_4$/PPy nanocomposite by varying its content in the ferrite material. The electrical, magnetic, and dielectric properties of the fabricated materials were studied to investigate their applications in electronic devices. The

magnetization saturation Ms, remanence Mr and coercivity Hc increase with the addition of ferrite material. The activation of the fabricated material increases from 0.11 to 0.34 eV, indicating the increase in electrical resistivity. The other important parameters such as squareness ratio and drift mobility were also calculated. The increment in DC electrical resistivity, saturation magnetic magnetization and remanence as well as reduction in dielectric constant values with the ferrite material addition in the polypyrrole suggest that the materials can be beneficial for recording media as well as high-frequency devices.

Research data policy and data availability statements

The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

References

1. M.S. Shah, F. Yasmeen, S.R. Ejaz, R.Y. Khosa, M. Imran, M.A. Assiri, I. Ahmad, N. Ahmad, A.R. Khan, H.M.T. Farid, J. Electron. Mater. **50**, 3976–3985 (2021)

2. R. Ramzan, M. Tariq, M.N. Ashiq, H. Albalawi, I. Ahmad, M. Alhossainy, S.R. Ejaz, R.Y. Khosa, H.M.T. Farid, H.M. Khan, J. Market. Res. **12**, 1104–1112 (2021)

3. A. Hakeem, T. Alshahrani, G. Muhammad, M. Alhossainy, A. Laref, A.R. Khan, I. Ali, H.M.T. Farid, T. Ghrib, S.R. Ejaz, J. Market. Res. **11**, 158–169 (2021)

4. A. Hakeem, T. Alshahrani, I. Ali, M. Alhossainy, R.Y. Khosa, G. Muhammad, A.R. Khan, H.M.T. Farid, Chin. J. Phys. **70**, 232–239 (2021)

5. T.H. Flemban, M. Sequeira, Z. Zhang, S. Venkatesh, E. Alves, K. Lorenz, I.S. Roqan, J. Appl. Phys. **119**, 065301 (2016)

6. I. Ali, M. Islam, M.N. Ashiq, M.A. Iqbal, H.M. Khan, N. Karamat, J. Alloys Compd. **579**, 576–582 (2013)

7. C. Ramana, Y. Kolekar, K. Kamala Bharathi, B. Sinha, K. Ghosh, J. Appl. Phys. **114**, 183907 (2013)

8. T.H. Flemban, V. Singaravelu, A.A.S. Devi, I.S. Roqan, RSC Adv. **5**, 94670–94678 (2015)

9. C. Radhakrishnamurty, S. Likhite, P. Sahasrabudhe, Proc. Indian Acad. Sci. Sect. A Earth Planet. Sci. **87**, 245–254 (1978)

10. P. Vasambekar, C. Kolekar, A. Vaingankar, J. Magn. Magn. Mater. **186**, 333–341 (1998)

11. R. Upadhyay, G. Baldha, Indian J. Phys. **63**, 835–838 (1989)

12. A. Hakeem, T. Alshahrani, H.M.T. Farid, A.R. Khan, M. Alhossainy, A. Laref, I. Ali, J. Mater. Sci. Mater. Electron. **32**, 2557–2563 (2021)

13. S. Yousaf, I. Ahmad, M. Kanwal, T. Alshahrani, H.H. Alhashim, N.A. Kattan, H.M.T. Farid, A. Riaz, T. Mehran, A. Laref, Mater. Sci. Semicond. Process. **122**, 105488 (2021)

14. S. Munir, I. Ahmad, A. Laref, H.M.T. Farid, Appl. Phys. A **126**, 1–7 (2020)

15. H.M.T. Farid, I. Ahmad, I. Ali, S.M. Ramay, A. Mahmood, J. Electroceram. **42**, 57–66 (2019)

16. K.Y. Butt, S. Aman, A.A. AlObaid, T.I. Al-Muhimeed, A. Rehman, H. Hegazy, N. Ahmad, A.R. Khan, S.R. Ejaz, H.M.T. Farid, Appl. Phys. A **127**, 1–11 (2021)

17. M.J. Iqbal, M.N. Ashiq, P. Hernandez-Gomez, J.M. Munoz, J. Magn. Magn. Mater. **320**, 881–886 (2008)

18. S. Li, L. Ge, H. Gu, Y. Zheng, H. Chen, L. Guo, J. Alloys Compd. **509**, 94–98 (2011)

19. U. Shinde, S.E. Shirsath, S. Patange, S. Jadhav, K. Jadhav, V. Patil, Ceram. Int. **39**, 5227–5234 (2013)

20. M. Ishaque, M. Islam, M.A. Khan, I. Rahman, A. Genson, S. Hampshire, Physica B **405**, 1532–1540 (2010)

21. G.R. Mohan, D. Ravinder, A.R. Reddy, B. Boyanov, Mater. Lett. **40**, 39–45 (1999)

22. M. Farid, I. Ahmad, G. Murtaza, M. Kanwal, I. Ali, J. Ovon. Res. **12**, 458 (2016)

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Ethics declarations

Conflict of interest

The authors declare that they have no conflict of interest.

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