Enhanced efficiency of bulk hetro junction photo voltaic cells through columnar phases of nano particles dispersed in discotic liquid crystalline materials

M. Bajpai[a] , N. Yadav[a] , S. Kumar[b], R. Srivastava[c] and Ravindra Dhar[a,*]
[a]Centre of Materials Sciences, University of Allahabad, Allahabad 211002, India
[b]Raman Research Institute, C.V. Raman Avenue, Bangalore, India-560080.
[c] Physics for Energy Harvesting Division, National Physical Laboratory, Dr. K. S. Krishnan Road, New Delhi-110012
*Emails: rdhar@alluniv.ac.in; dr.ravindra.dhar@gmail.com

Bulk hetero-junction photovoltaic cells based on composites of copolymer Poly [N-90-hepta-decanyl-2,7-carbazole-alt-5,5-(40,70-di-2-thienyl-20,10,30-benzothiadiazole)] and the fullerene derivative,[6,6]-phenyl C71-butyric acid methyl ester with an inserted layer of discotic liquid crystalline material between the interface of active layer and hole transporting layer have been fabricated. Different hole transporting layers deposited on indium tin oxide substrates such as poly (3,4ethylenedioxythiophene)-poly(styrene sulfonate) or molybdenum trioxide has been used in these devices. Efforts are also being made to enhance the efficiency by using composites of nano particles and discotic liquid crystals [1,2]. Devices with inserted discotic liquid crystal layer showed better performance than the reference cells. Power conversion efficiency of 5.1% has been achieved for these photovoltaic solar cells containing self-organized discotic liquid crystal layer of 30 nm thickness under one sun condition [3]. The mobility of holes in the HAT4 inserted devices was found to be of the order of 10^{-6} due to which high values of current density was achieved. The influence of varying the thickness of liquid crystal layer, annealing and doping of nano particles on the photovoltaic parameters of these devices will be discussed.

References

[1] N. Yadav, S. Kumar, R. Dhar, “Cadmium selenide quantum dots for the amelioration of the properties of a room temperature discotic liquid crystalline material,” *RSC Adv.*, **5**(96), 78823-78832 (2015).

[2] R. Dhar, S. Kumar, R. Dabrowski, “Optimization of the electrical parameters of nematic and discotic liquid crystalline materials due to the dispersion of nano particles, nano tubes and quantum dots for display and photo-voltaic applications,” Nanotech **2013** Vol. 1, p. 542-545. (*In Chapter 6-Composite Materials of Vol-1 on Advanced Materials, CNTs, Particles, Films and Composites*), ISBN: 978-1-4822-0581-7.

[3] M. Bajpai, N. Yadav, S. Kumar, R. Srivastava and R. Dhar, “Incorporation of liquid crystalline triphenylene derivative in bulk heterojunction solar cell with molybdenum oxide as buffer layer for improved efficiency,” *Liq. Cryst.*, **43**, 928-936 (2016).

Speaker Biography

Ravindra Dhar received his doctorate degree (D.Phil.) in Science from the University of Allahabad (India) in 1997. He is currently Professor of Materials Science and Founder Chairman, Centre of Materials Sciences, University of Allahabad, Allahabad. He is recipient of a National Research Award from the University Grants Commission, New Delhi. Presently, he serves as Secretary, Indian Liquid Crystal Society and Fellow of the Institution of Electronics and Telecommunication Engineers, India. He is also the Secretary of International Academy of Physical Sciences. His research interest is focused on induced phases in LC mixtures, TGB, FLC and AFLC phases of liquid crystals, radiation induced transformations of materials, solar cells and nano systems. He has published more than 125 research papers in these areas. Currently, he is a member of the editorial board of Phase Transitions (Taylor & Francis) and is Associate Editor of The Open Chemistry Journal from Bentham.