Supporting Information

$CuBi_2O_4$ Nanocrystals Integrated with the Polyaniline Nanobelt Arrays for Weak Light Photomultiplication Type Photodetector

Anshika Singh[a], Pratima Chauhan[a], Arpit Verma[b], Bal Chandra Yadav[b]

[a]Advanced Nanomaterials Research Laboratory, U.G.C. Centre of Advanced Studies, Department of Physics, University of Allahabad, Prayagraj-211002, India

[b]Nanomaterials and Sensors Research Laboratory, Babasaheb Bhimrao Ambedkar University, Lucknow-226025, U.P., India

Email-id: anshikasingh@allduniv.ac.in; mangu167@yahoo.co.in

1. Surface Morphological Analysis

Surface morphology of the $CuBi_2O_4$ NCs investigated by the scanning electron micrographs (SEM) and in Fig. S1 (a and b) shows nanopellets like structures at 2 µm. Fig. S1 (c and d) shows symmetric and almost the same size as the pellets as clearly shown in the micrographs at 1 µm and 0.5 µm respectively.

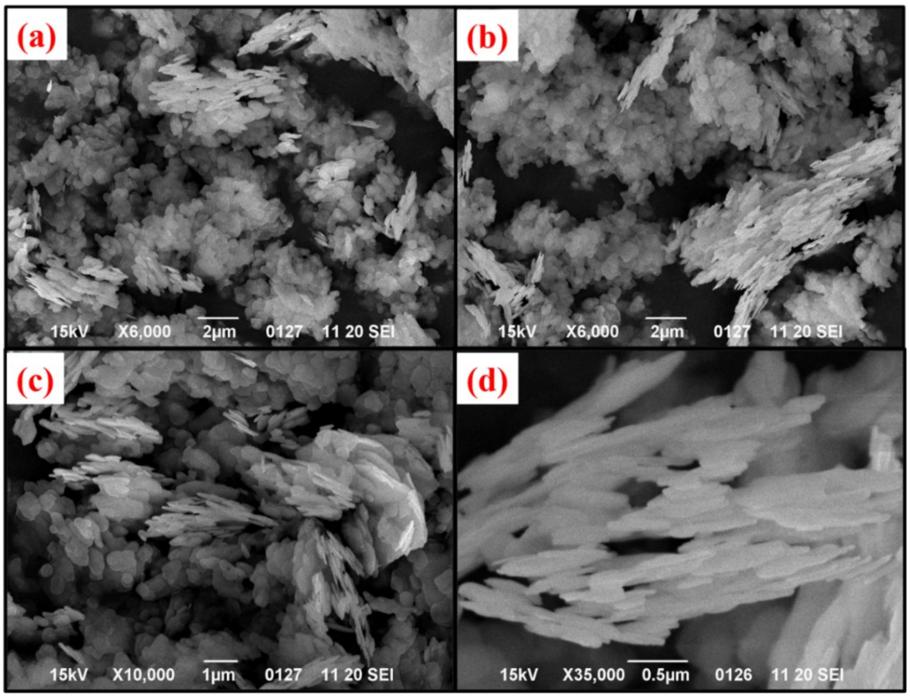

Fig. S1 SEM images at (a) 2 µm (b) 2 µm (c) 1 µm (d) 0.5 µm.

2. X-ray Diffraction

In the XRD pattern of $CuBi_2O_4$ the characteristics peaks are (200), (211), (220), (002), (102), (310), (112), (311), (202), (400), (222), (312), (411), (420), (213), (402), (332), (502), (442), and (612) found, which corresponds to the 2θ angles of 21.051°, 26.597°, 28.143°, 31.015°, 32.070°, 32.782°, 35.359°, 36.390°, 38.648°, 42.697°, 43.164°, 45.888°, 46.477°, 48.440°, 52.195°, 53.766°, 55.852°, 63.240°, 71.020°, and 74.848°. The average crystallite size was calculated by the Scherrer formula as in relation (S1) and found to be 37.37 nm.

$$D = \frac{k\lambda}{\beta \cos\theta} \tag{S1}$$

Where k is the Scherrer constant, λ is the Cu K_α wavelength (0.15406 nm), β is the full width and half maxima and θ is the Braggs angle.

3. Characterization Tools

The structural study is carried out using a Bruker D8 Advance Eco X-ray diffractometer, and the surface morphological examinations are carried out using a JEOL JSM 6490 LV Scanning Electron Microscope (SEM). Thermo- Scientific's Nicole 6700 spectrometer performs Fourier transform infrared spectroscopy. We utilize a Thermo-Scientific Evolution 201 spectrophotometer for UV-Visible spectroscopy. Malvern Nanozetasizer, Model: NZS90, UK, is used to measure particle size. The photodetector device was examined using a Keithley source meter (6517 B), a source of wavelength 365 nm and Newport optical meter.

4. Device Fabrication

For the fabrication of the photodetector device, the following processes were followed in order. The first procedure involved cutting cotton substrates into 1×1 cm^2 and dissolving the 0.2 g of $CuBi_2O_4$-polyaniline in 1.5 mL of N-Methyl-2-pyrrolidone (NMP) in an ultrasonic bath for 50 minutes. This cotton substrate was dipped into the solution and dried in a 30°C oven for 30 min. This process was repeated three times to form a dense film of $CuBi_2O_4$-polyaniline on cotton fabrics. In the last phase, silver electrodes with a channel width of 2 mm and a length of 3 mm were painted on the substrates.

5. Results and Discussion

All the parameters of the $CuBi_2O_4$-polyaniline photodetector device at the illumination intensity of 50 μW/cm^2 with varying potential drift as tabulated in Table S1. On the other hand, figures of merit of the $CuBi_2O_4$-polyaniline photodetector device for different illumination intensities at the potential drift of 1 V.

Qualitative parameters for our $CuBi_2O_4$-polyaniline photodetector device

Table S1

On/Off ratio (Ip/Id)	**Responsivity (A/W)**	**LDR (dB)**	**EQE (%)**	**Detectivity (Jones)**	**NEP (W)**	**Gain**	**Voltage (V)**
7.55	32.77	17.56	1.11×10^{4}	3.66×10^{12}	3.05×10^{-7}	7.39×10^{10}	50
4.25	16.26	12.57	5.51×10^{3}	1.82×10^{12}	6.15×10^{-7}	3.66×10^{10}	25
3.18	10.93	10.06	3.70×10^{3}	1.22×10^{12}	9.15×10^{-7}	2.46×10^{10}	10
2.64	8.19	8.43	2.77×10^{3}	9.16×10^{11}	1.22×10^{-6}	1.85×10^{10}	5
2.31	6.55	7.27	2.22×10^{3}	7.33×10^{11}	1.53×10^{-6}	1.47×10^{10}	2
2.07	5.38	6.35	1.824×10^{3}	6.016×10^{11}	1.858×10^{-6}	1.21×10^{10}	1

Table S2

On/Off ratio (Ip/Id)	Responsivity (A/W)	LDR (dB)	EQE (%)	Detectivity (Jones)	NEP (W)	Gain	Intensity (μW/cm²)
3.14	1.43	9.94	484.11	1.59×10^{11}	7.00×10^{-6}	3.22×10^{9}	375
2.79	2.25	8.94	761.95	2.51×10^{11}	4.45×10^{-6}	5.06×10^{9}	200
2.35	2.25	7.42	761.94	2.51×10^{11}	4.45×10^{-6}	5.06×10^{9}	150
2.13	2.82	6.55	955.42	3.15×10^{11}	3.55×10^{-6}	6.35×10^{9}	100
2.07	5.38	6.35	1824.37	6.02×10^{11}	1.85×10^{-6}	1.21×10^{9}	50