



## Photophysical Properties of New Blue Light Emitting 2-(2-Bromo 4-Cyno Phenyl)-4 Phenyl Quinoline (Br-CN-DPQ) Organic Phosphor for Solid State Lighting

M.V.Ghate<sup>1</sup>, H.K. Dahule<sup>1</sup>, S.J.Dhoble<sup>2</sup> and R.P.Urkude<sup>1</sup>

<sup>1</sup>Department of Physics Shivaji Science College, Congress Nagar, Nagpur-440012, India

<sup>2</sup> Department of Physics, Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur 440033, India

Corresponding author Email : [hkdahule@yahoo.co.in](mailto:hkdahule@yahoo.co.in)

### Abstract:

The electroactive and blue luminescent substituted diphenyl quinoline Br-CN-DPQ have been synthesized and characterized by photophysical properties. Br-CN-DPQ exhibits intense blue emission in range 444nm-440nm in different solvents. Br-CN-DPQ shows remarkable large Stokes shift which is applicable for good light emission. UV-Vis optical absorption spectra of Br-CN-DPQ in different solvents shows three absorption bands in the range of 303-398 nm, which is related to  $\pi-\pi^*$  and  $n-\pi^*$  transitions. UV-Vis absorption spectrum was employed to calculate the energy band gap. A narrow full width at half-maximum (FWHM) value of PL spectra can be obtained, may be useful for developing organic luminescent devices, solar cell devices, or in chemical sensors. Beside this, the Oscillator strength, energy band gap are examined by using UV-vis absorption spectra.

**Keywords:** Br-CN-DPQ, Friedlander reaction, OLED, solid-state lighting, display device.

### 1. Introduction

Considerable progress in recent years resulted in flat-panel displays based on OLEDs for cell phones and digital cameras. However, major challenges such as need to significantly improve the performance and durability of blue, green, red, and white OLEDs for displays and lighting remained unattended [1-4]. One of the key challenges on the path to develop the next generation of high-performance OLEDs is the design and synthesis of readily processible, thermally robust, emissive and charge transport materials with improved multifunctional properties. OLED's recently owing to their overwhelming merits of lower power consumption, higher energy efficiency; longer operate life-times, and eco-friendly constituents, compared to the traditional incandescent and mercury-containing fluorescent lightings [5-9]. Greater success has been achieved in the development of a green and red emitter than that of a blue in both fluorescent and phosphorescent

displays. The development of blue phosphorescent organic light-emitting diodes (PHOLEDs) [10] is of great importance due to strong demand for high efficiency blue devices which can substitute common low efficiency blue fluorescent devices. However, the blue PHOLEDs have a critical problem of short lifetime [11] because of lack of stable high triplet energy host and charge transport materials which can confine triplet excitons and prolong the lifetime of the blue PHOLEDs. Thus it should be improved, particularly in terms of efficiency and color purity to match the National Television System Committee (NTSC) standard color definition for display applications [12-13]. Pyrazoloquinoline derivatives, distyrenes, anthracene derivative, spirofluorenes are demonstrated to be blue emitting materials for fabricating blue organic lighting emitting diodes (OLEDs) [14-15]. Pyrazoloquinoline derivatives have been intensively studied for use as the blue host material in OLEDs because of their excellent optical properties, such as engineering of thermally-activated delayed fluorescence emitters [16]. There is a development in series of pyrazoloquinoline derivatives, which give bright blue EL emission [17]. This blue light emitting phosphor find applications in fabricating white OLEDs for solid state lighting and display devices.

### 2. Experimental

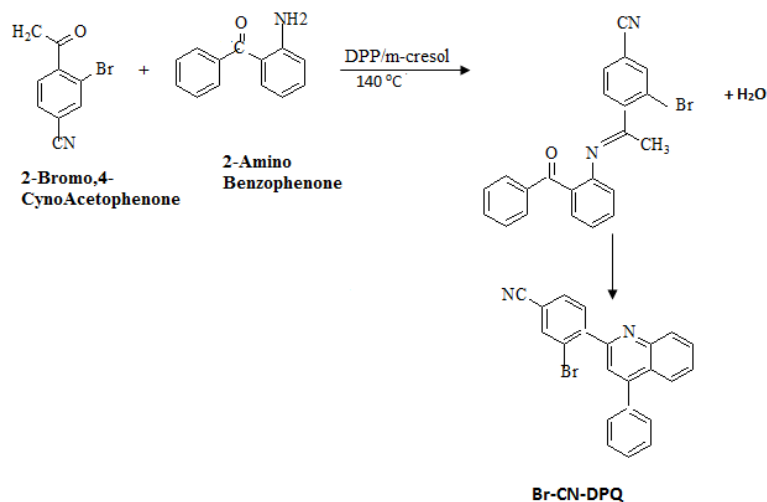
#### 2.1. Synthesis of ligand 2-(2-Bromo,4-Cyno phenyl) 4-phenyl quinoline ( Br-CN-DPQ)

The Br-CN-DPQ were synthesized conveniently according to Scheme-I from the condensation of 2-bromo 4 -cyno Acetophenone and 2-Amino benzophenone using the acid-catalyzed Friedlander reaction [18-19].

2-bromo 4 -cyno Acetophenone (1gm) and 2-Amino benzophenone (1gm) were added along with 1gm of diphenyl phosphate and 3ml of m-cresol in a glass reactor fitted with mechanical stirrer. Heat the reaction mixture at 90°C for 1 h and then for 4 h at 140 °C . After cooling, methylene chloride (100 ml) and 10% NaOH (100

ml) were added to reaction mixture. The organic layer was separated and collect this layer on watch glass to evaporate remaining dichloromethane. Then washed with distilled

water (50 ml×5 times) and Hexane(20 ml×5 times) to obtain crystalline solid of Bromo-Cyno Diphenylquinoline [C<sub>22</sub>H<sub>13</sub>N<sub>2</sub>Br]. Relative molar mass of Br-CN-DPQ = 385.24 gm.



Scheme1: Synthesis of Br-CN-DPQ

**3. Result and Discussion**

**3.1. Photophysical properties**

**(a) UV-Vis absorption**

The Absorption spectras of Br-CN-DPQ in different solvents at room temperature is shown in fig.1. The spectra contain three notable peaks. The shapes of absorption spectra of compound in different solvents are similar. The UV-VIS absorption spectra could provide a good deal of information on the electronic structures of the polymeric compound. The maximum absorption

peaks region is in range 300nm-303nm. The second shoulder obtained at 328nm. The lowest-energy absorption bands located in the range of 393nm-398nm can be due to the n-π\* transition assigned to the intermolecular charge transfer (ICT). The numbers of shoulders of absorption spectra's are due to the different bond vibration. The intensity of absorptions peak approximately reduces to zero at 450 nm.

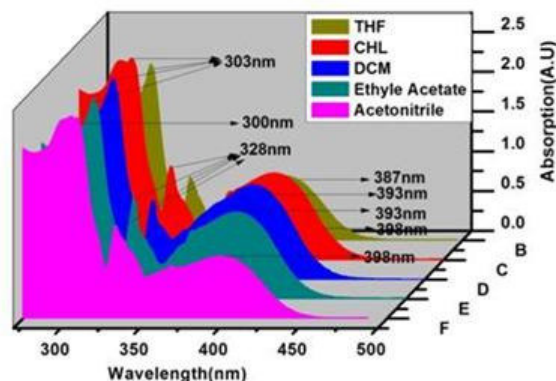


Fig.1. Absorption spectra of Br-CN-DPQ in 10<sup>-4</sup> mol different solvents

The band gaps were calculated by means of extrapolation of the (αhν)<sup>2</sup> versus hν plot, described by Morita et al., [20]. [Fig 2].

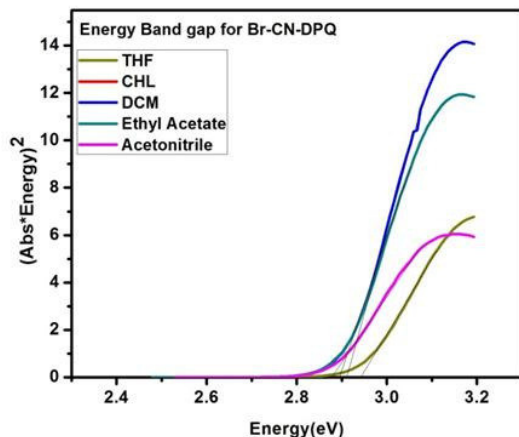


Fig.2. De termination of band gap  $E_g$  for Br-CN-DPQ in different solvents

The calculated energy band gap for Br-CN-DPQ found to be in the range of 2.87eV-2.94eV in different solvents. The energy band gap for different peak value has been mentioned in Table1.

The speed of transmitted light depends upon the optical density of that particular material through which it passes. The calculated optical density for Br-CN-DPQ is given in table 1.

**(b)Photoluminescence spectra**

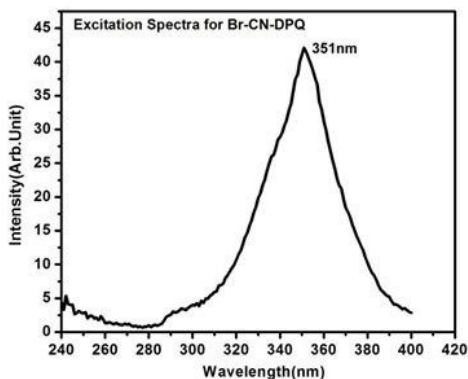


Fig.3:Excitation spectra of Br-CN-DPQ

Fig.3. shows excitation spectra for Br-CN-DPQ. When Br-CN-DPQ in different solvents excited at 351nm, it shows same emission wavelength. The PL spectra Br-CN-DPQ in different solvent (Fig.4) displayed blue phosphorescence. When

Br-CN-DPQ excited then it gives blue emission in the range 440nm-444nm, due to the presence of electron-withdrawing bromo and cyano substituent groups in 2-4 diphenyl quinoline.

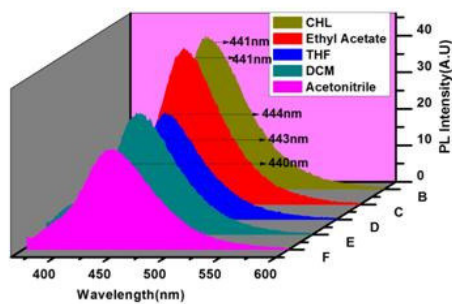


Fig.4. The PL spectra Br-CN-DPQ in different solvent

The CIE chromaticity diagram is as shown in given fig.5. The color of the synthesized Br-CN-DPQ phosphor phosphorescence is calculated from the emission spectrum using the chromaticity coordinate calculation method based on the CIE 1931 (Commission International

d'Eclairage) system [21-22]. Chromaticity coordinates of Br-CN-DPQ in different solvents are in the blue region. CIE Co-ordinates with full width at half maximum (FWHM) value are in different solvents mentioned in Table 1.

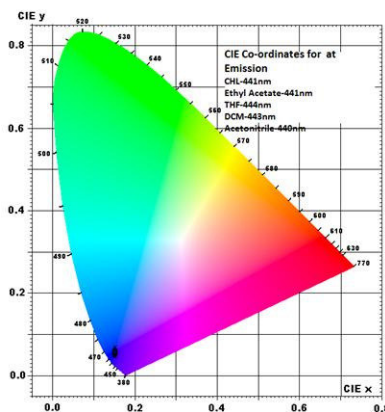


Fig.5: CIE 1931 (x, y) diagram displaying emission color coordinates of Br-CN-DPQ

**Table 1. Uv-Vis and Photoluminescence parameters for Br-CN-DPQ**

Solvent	$\lambda_{Abs}^a$ (nm)	$\lambda_{Emi}^b$ (nm)	$E_g^c$ (eV)	O.D <sup>d</sup>	$T^e$	CIE Co-ordinate	FWHM <sup>f</sup> (nm)
THF	303	444	3.76	2.22	5.11	X=0.1506, Y=0.0492	58
	328		3.45	0.79	1.82		
	387		2.94	0.81	1.87		
Chloroform	303	441	3.72	2.51	5.78	X=0.1513, Y=0.0566	66
	328		3.46	1.17	2.69		
	398		2.87	1.09	2.51		
Di chloro methane	303	443	3.82	2.51	5.78	X=0.1505, Y=0.0612	67
	328		3.51	0.98	2.25		
	393		2.91	1.19	2.74		

Ethyl acetate	303	441	3.82	2.51	5.78	X=0.1514, Y=0.0536	64
	328		3.51	1.3	2.99		
	393		2.89	1.09	2.51		
Acetonitrile	300	440	3.80	2.54	5.85	X=0.1519, Y=0.0693	75
	328		3.5	1.17	2.69		
	398		2.84	0.77	1.77		

<sup>a</sup> maximum Absorption Wavelength

<sup>b</sup> Maximum emission Wavelength

<sup>c</sup> Energy band gap(Using UV)

<sup>d</sup> Optical density=A/L

<sup>e</sup> Optical depth(T) = A ln10(Using UV-spectra)

<sup>f</sup> Full width half maxima(Using PL)

### 3. Conclusion

The Br-CN-DPQ has been synthesized in nearly quantitative yield by Friedlander condensation. In conclusion, The Br-CN-DPQ, organic compound is a blue light emitting chromophore in solid crystalline powder. The synthesized Br-CN-DPQ powder when excited at 351 nm shows the emission in the region 440nm-444nm with CIE Co-ordinates in blue region. The deep-blue emitters with ideal CIE coordinates (CIEy ≤ 0.1) have been successfully developed to furnish the desired blue pixel for future flat-panel displays and lighting sources. Using UV-Vis absorption and photoluminescence (PL) spectroscopy, basic photo physical characteristics such as the absorption maxima ( $\lambda_{Abs}$ ), optical band gaps ( $E_g^{opt}$ ), maximum intensity and emission wavelength of the molecules are determined. It is very promising for applications in flexible organic devices and to be cheaper and more saving energy efficient than the technologies currently available.

### 5. REFERENCES

P. Gordon, P. Gregory. Organic Chemistry in Color, Springer-Verlag, Berlin, 1987.  
 Goyal, R. K.; Damkale, S. R.; Mulik, U. P.; Negi, Y. S.; Dadge, J. W.; Aiyer, R. C. *Adv. Mat Lett.* 1(2010) 264.  
 Shukla, S. K.; Bharadvaja, A.; Tiwari, A.; Parashar, G. K.; Dubey, G. C. *Adv. Mat Lett.* 1(2010) 129.  
 S. E. Gledhill, B. Scott, B. A. Gregg, *J. Mater. Res.* 2005, 20, 3167.  
 S. E. Gledhill, B. Scott, B. A. Gregg, *J. Mater. Res.* 2005, 20, 3167.  
 S.Pimputkar, J.S.Speck,S.P.DenBaars, S.Nakamura,Prospects for LED lighting.*Nat.Photonics*3(2009)180-182

Ide N, Tsuji H, Ito N, Sasaki H, Nishimori T, Kuzuoka Y, *SPIE* 2008;7051:705119-21.  
 Huang Q, Walzer K, Pfeiffer M, Lyssenko V, He G, Leo K. *Appl. Phys. Lett.* 2006;88:113515.  
 Schwartz G, Reineke S, Rosenow TC, Walzer K, Leo K. *Adv. Funct. Mater.* 2009;19:1.  
 S. M. Kim, J. H. Kim, S. K. Jeon, J. Y. Lee. *Dyes and Pigments* ,2016, 125,274-281.  
 A. Tamayo, B. Alleyne, P. Djurovich, S. Lamansky, I.Tsyba, *J Am Chem Soc* 2003,125,7377-87.  
 S.-J. Kim, Y. Zhang, C. Zuniga, S. Barlow, S.R. Marder, B. Kippelen, *Org. Electron*,2011, 12, 492-496.  
 S.F. Varol, S. Sayin, S. Eymur, Z. Merdan, D. Unal. *Organic Electronics* ,2016, 31,25-30  
 A. Rajagopal, C.I. Wu, A. Kahna, *J. Appl. Phys.* 83 (1998) 2649.  
 B.M. Bahirwar, R.G. Atram, R.B. Pode, S.V. Moharil, *Mater. Chem. Phys.* 106(2007) 364.  
 B.M. Bahirwar, R.G. Atram, R.B. Pode, S.V. Moharil. *Mater Chem Phys*, 2007,106,364-368.  
 Y.T Tao, E. Balasubramaniam, A. Danel, A. Wisla, P. Tomasik, *J. Mater. Chem.* 11(2001) 768.  
 S.Morita, T.Akashi, A.Fujii, M.Yoshida, Y.Ohori, K.Yoshimoto, T.Kawai,A.A.Zakhidrov, S.B.Lee, K.Yoshino, *Synth. Met.* 69 (1995) 433.  
 B.M. Bahirwar, D. H. Gahane, R.G. Atram, S. V. Moharil, *Physics Procedia* 2( 2012 ) 50 – 54  
 E.A.Fehnel, *J. Org. Chem.* 31 (1966) 2899  
 Minakshi Ghate1, H.K. Dahule, S.J.Dhoble. *JRBAT, Special Issue-(6), October 2015*  
 N. Thejo Kalyani, S.J. Dhoble, *Renewable and Sustainable Energy Reviews* 16 (2012) 2696– 2723

