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H05B 33/22

H01L 29/00

H01L 35/24

B32B 9/04

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(43)

10-2005-0014800

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(87)

WO 2003/084292

(86) 2003 03 28

(87)

2003 10 09

(30) 60/368,130 2002 03 29 (US)

(71) 02139 77

, 08618, , 375

(72) 02402 16

02472 14

12142 5 60

02116 #5 263

(74)

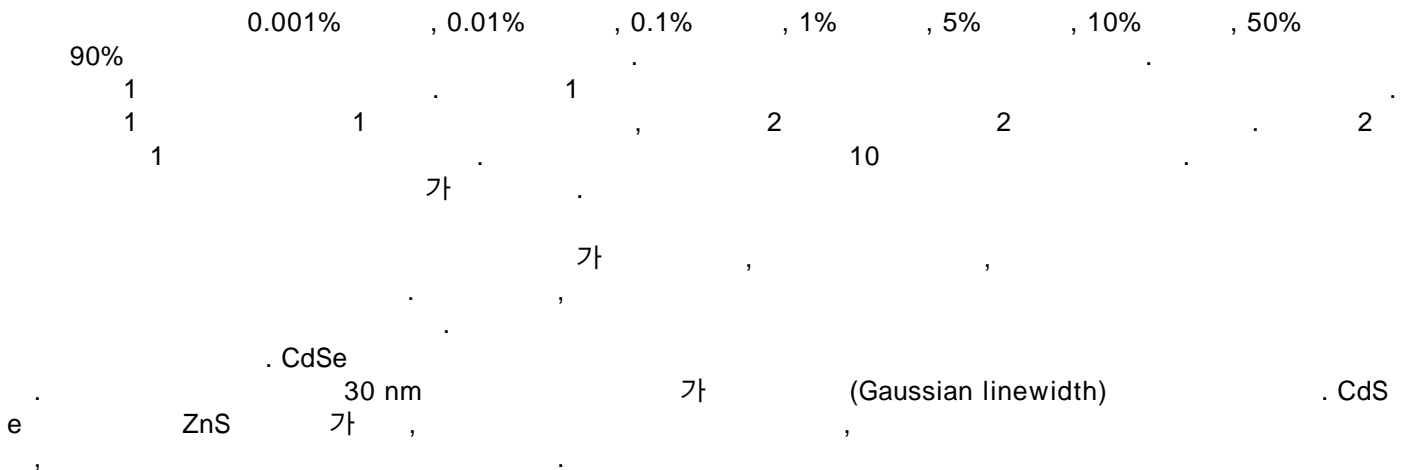
:

(54)

(:), (:) (照射)
 () 가 ,
) 가 . (,
 (radiative recombination) (/
 (cd/m²) (W/m²)
 (operating half-lives)
 0 nm (zero dimension) 1~1
 가 (complex heterostructures)
 CdSe ZnS 2 2 1
 가 1 2 1 , 1 , 1
 2 가 2
 , 1 2 , 1 2
 (blocking layer) 1 2
 1 2
 2 가 1 2
 2,000 가
 2
 1
 7 mA/cm² , 0.1% , 0.2% , 0.3% , 0.4% 0.6%
 , 1 mA/cm² , 1000 cd/m² , 1200~1500 cd/m² 가
 125 mA/cm² , 1.0% 가 , 570 nm
 1.2 cd/A (luminescence efficiency) 가
 36 nm (full width at half maximum) 가
 % (fluorescence efficiency)
 . C.B. Murray et al., J. Amer. Chem. Soc. 1993, 115, 8706, B.O. D

abbousi et al., J. Phys. Chem. B 1997, 101, 9463

가
(organic, surface-passivating ligand)



1

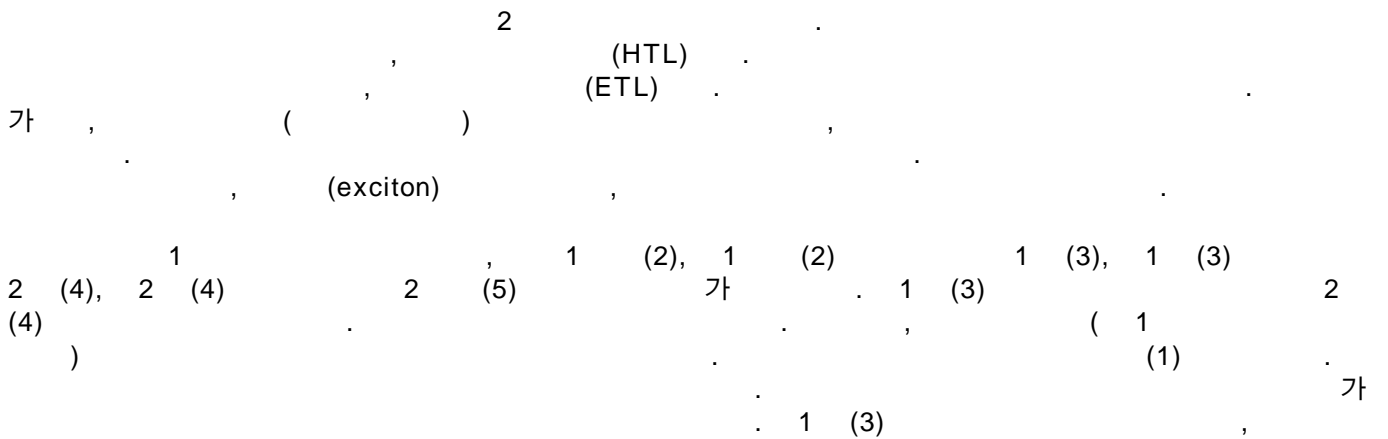
2a 2g

3

4a 4b

5 : N,N'- -N,N'- (3-)-(1,1'-)-4,4'- :

6 2



(ITO) (work function)가
 (polyaniline) (Ab:Ag) 가 (Al, Ba, Yb, Ca, (Li:Al) Mg:Ag 2
 ITO 50 1000 1000 200 1000 2
 (ETL) 8- (Alq₃) ETL (thioxinoid)
 (organic chromophore) HTL (TPD) N,N'-
 -N,N'-(3-)-1,1'- (1,1'-)-4,4'- (9-
)-1,1'- N,N,N',N'- 3 , 4,4'-
 2 가
 3 가 가
 , CdSe 가 , InAs
 75 nm, 15% 60 nm, 10% 40 nm, 가 5% 30 nm (F
 WHM) , 10%, 20%, 30%, 40%, 50%, 60%, 70% 80% 가
 가
 ZnS, ZnSe, ZnTe, CdS, CdSe, CdTe, HgS, HgSe, HgTe, AlN, AlP, AlAs, AlSb, GaN, GaP, GaAs, GaSb, GaSe, InN, InP, InAs, InSb, TiN, TiP, TiAs, TiSb, PbS, PbSe, PbTe

(coordinating solvent) (discrete nucleation) 가 , 6,322,901

M (donor) X 가
 (steady growth) 가 가 가

가 , 가 . M X
 가 , M X M MX
 (tris(silyl pnictide))
 (TBPSe) ((TMS)₂Se), (-n-) (TOPSe) (-n-)
 (HPPTTe) (TOPTe)
 (TMS)₂Te), () ((TMS)₂S), (-n-) (TOPS)
 (, NH₄Cl) () ((TMS)₃P),
 () ((TMS)₃As), () ((TMS)₃Sb)
 M X

가
 (tHPP) (TOP), (TOPO)가 (TOPO)
 (absorption line widths)

가
 CdSe CdTe 300 nm 5
 400 nm 800 nm
 150 15 125
 M MX
 , X

ZnS, ZnSe, ZnTe,
 CdS, CdSe, CdTe, HgS, HgSe, HgTe, AlN, AlP, AlAs, AlSb, GaN, GaP, GaAs, GaSb, GaSe, InN, InP, InAs, InSb, TiN, TiP, TiAs, TiSb, PbS, PbSe, PbTe
 CdSe CdTe ZnS, ZnSe CdS
 6,322,901
 01 가 1 10

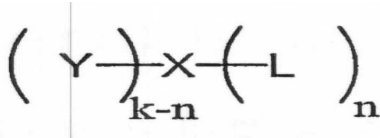
(poor solvent) 6,322,901 /
 10% (size selective precipitation) 가
 가 (supernatant) (opalescence)
 / /
 5% rms 가 15% rms 10% rm
 d) (overlayer) (cappe)

가

6,251,303

가

가



, k 2, 3 5 , n 1,2,3,4 5 , k-n (0) . X O,S,S=O, SO₂, Se, Se=O, N, N=O, P, P=O, As As=O . Y L C₂₋₁₂, C₁₋₄, C₂₋₄, C₂₋₄, C₁₋₄, C₁₋₄, C₃₋₅, C₃₋₅, C₁₋₄, C₁₋₄, C₁₋₄, -O-, -S-, -N(R^a)-, -N(R^a)-C(O)-O-, -O-C(O)-N(R^a)-, -N(R^a)-C(O)-N(R^b)-, -O-C(O)-O-, -P(R^a)-P(O)(R^a)-가 R^a R^b

(phenanthryl)

J.March 'Advanced Organic Chemistry'

가

(drop casting)

가

12

24

(TEM)

가

herence length)

가

Scherrer

가

X (XRD) X (co

x

UV/V

; HTL)

N,N'- -N,N'- (3-)-(1,1'-)-4,4'- (TPD) (

. HTL

(pinhole short)

(EML)

. TPD

가

, TOPO가

. TPD

()

(8-)(Alq₃)

ITO

, Alq₃ (ETL)

. TPD HTL ()

가

. Alq₃

/

가

2a (EBL), 2g (HBL)

. (eBL)

2c -1,2,4-

2g (TAZ), 3,4,5- -1,2,4- , 3,5- (4- -)-4- -5- - (BCP), 4,4',4'- {N-(3-)-N- } (m-MTDATA), (PEDOT), 1,3- (5-(4-) -1,3,4- -2-) , 2-(4-)-5

-(4-)-1,3,4- , 1,3- [5-(4-(1,1-))-1,3,4- -2-] ,
 1,4- (5-(4-) -1,3,4- -2-) 1,3,5- [5-(4-(1,1-))
 -1,3,4- -2-] , BCP HBL 가 Alq₃
 가 Alq₃ , Alq₃ TPD-
 가 가 가
 (Forster) (Dexter)
 () 3 (a) (b)
 q₃ 0.1 mA/cm² 1.0% 가 (turn-on)
 6V

Bulovic et al., Semiconductors and Semimetals 64, 255 (2000), Adachi et al., Appl. Phys. Lett. 78, 1622 (2001), Yamasaki et al., Appl. Phys. Lett. 76, 1243 (2000), Dirr et al., Jpn. J. Appl. Phys. 37, 1457 (1998), D'Andrade et al., MRS Fall Meeting, BB6.2 (2001)
 가 /

ZnS CdSe 50% (photoluminescence quantum efficiency) 가 (lumophores) Hines et al., J. Phys. Chem. 100, 468 (1996) CdSe 23
 55 470 nm 640 nm
 가 40 nm , Dabbousi et al., J. Phys. Chem. 101, 9463 (1997)
 가 (saturated color emission)
 가 가 (chromophore)
 2 가
 (degeneracy) , 가 가
 (unity efficiency) () (>0.5)
 μs) (10μs), 가

가 가 300 nm 400 nm, 400 nm 700 nm, 700 nm 300 nm 2,500 nm
 0 nm , PbSe 1100 nm, 1100 nm 2500 nm 250
 600 nm , Alq₃ ETL 1550 nm , TPD HTL, 4 nm PbSe
 1300 nm 1

2a (TOPO) Murray, et al., J. Am. Chem. Soc. 115, 8706(1993) 562 nm
 , 548 nm . CdSe 38 , ZnS 1.5
 1 6 가 , 48 CdSe 30% 2 가
 가 가 가
 -N,N'- (3-)-(1,1'-)-4,4'- (TPD) N,N'
 ITO가 , 40 nm , 40 nm

(8-1 mm, 75 nm) (Alq₃) TPD: , 50 nm Ag
 (10:1) Mg:Ag 5 ppm
 CdSe
 TOPO가
 10 mg/mL 가 TPD
 TPD 가 Alq₃ 3
 (shoulder) 530 nm . 562 nm Alq₃ Alq₃ 60%
 4 . 45% 7 mA/cm² 10.
 5V (5~1900 cd/m²) 0.5%
 21 mA/cm² 0.61% . 125 mA/cm² , 1900 cd/m² , 1.5 cd/A
 25 , Schla
 mp, et al., J. Appl. Phys. 82, 5837 (1997) . 0.1 1.0 mA/cm² 1.0%
 90% (robust material system)
 TPD 가
 TPD: , Alq₃ 가
 Alq₃ Alq₃ TPD: Alq₃ 가
 90%가
 1.0% , 0.61%
 2/3 (trap emission) (<1 mA/cm²)
 (tail) (~100 mA/cm²)
 TPD (neat film) TPD (TPD:) , Alq₃ , 2a TPD 5
 가 20 가 400 가
 50 TPD 2a Alq₃ 가
 50 TPD Alq₃ 가 TPD/Alq₃ , TPD Alq₃ 가
 Forster (~40) (TPD Alq₃ 가 가 35%가
 TPD 가 :TPD
 10% 30 Forster ZnS

6 2b . 가 , Hill et al., J. Apply. Phys. 86, 4515 (1999) . (UPS) 가
 . Alq₃ , ITO 가 Mg TPD Alq₃
 , TPD , TPD (LUMO) , TPD , 가 Alq₃
 TPD Alq₃ , TPD , TPD ,
 hem. Phys. 106, 9869 (1997) , 가 , Kuno et al., J. C
 re, 395, 151 (1998) , 가 , Baldo, et al., Natu
 (30%) , Shimazu et al., Phys. Rev. B, 63, 205316-1(2001) . 가
 가 Auger 가 2 가 2 가 2 가
 가 가 ,
 31 nm FWHM , 60 100 nm FWHM , Liu et al., Ap
 pl. Phys. Lett. 79, 578 (2001) and Kwong et al., Chem. Mat. 11, 3709 (1999) . 가
 (sterically) , Tamarat et al., J. Phys. Chem. A 104 (2000) . 가
 Lett. 77, 3873 (1996) . FWHM 14 nm , Empedocles et al., Phys. Rev.
 , 31 nm 10%
 25 nm
 가 , 1%
 o et al., J. Chem. Phys. 106, 9869 (1997) . FWHM , Kun
 CdSe(ZnS)
 25
 가 ,

(57)

1.

1. 1, 2
2. 1, 2
3. 1, 2
4. 1, 2
5. 1, 2
6. 1, 2
7. 1, 2
8. 1, 2
9. 1, 2
10. 1, 2
11. 1, 2
12. 1, 2

2

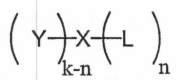
300 nm 400 nm

400 nm 700 nm

700 nm 1100 nm

1100 nm 2500 nm

2500 nm



, k 2,3 5 , n 1,2,3,4 5 , k-n , X O,S,S=O, SO₂, Se, Se=O, N, N=O, P, P=O, As As=O , Y L , , , , C₂₋₁₂ , C₁₋₄ , C₂₋₄ , C₂₋₄ , C₁₋₄ , C₁₋₄ , C₃₋₅ , C₃₋₅ , C₁₋₄ , C₁₋₄ -O-, -S-, -N(R^a)-, -N(R^b)-C(O)-O-, -O-C(O)-N(R^a)-, -N(R^a)-C(O)-N(R^b)-, -O-C(O)-O-, -P(R^a)- -P(O)(R^a)가 , R^a R^b , , , , ,

13.

1

14.

13

2

15.

14

16.

14

17.

14

18.

1

ZnS, ZnSe, ZnTe, CdS, CdSe, CdTe, HgS, HgSe, HgTe, AlN, AlP, AlAs, AlSb, GaN, GaP, GaAs, GaSb, GaSe, InN, InP, InAs, InSb, TiN, TiP, TiAs, TiSb, PbS, PbSe, PbTe

19.

18

ZnS, ZnSe, ZnTe, CdS, CdSe, CdTe, HgS, HgSe, HgTe, AlN, AlP, AlAs, AlSb, GaN, GaP, GaAs, GaSb, GaSe, InN, InP, InAs, InSb, TiN, TiP, TiAs, TiSb, PbS, PbSe, PbTe

20.

1

2

1

2

21.

20

22.

21

23.

20

24.

20

25.

20

2

26.

20

300 nm

400 nm

27.

20

400 nm

700 nm

28.

20

700 nm 1100 nm

29.

20

1100 nm 2500 nm

30.

20

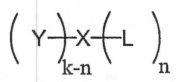
2500 nm

31.

20

32.

20



, k 2,3 5 , n 1,2,3,4 5 , k-n , X O,S,S=O, SO₂, Se, Se=O, N, N=O, P, P=O, As As=O, Y L , C₂₋₁₂, C₁₋₄, C₂₋₄, C₂₋₄, C₁₋₄, C₁₋₄, C₃₋₅, C₃₋₅, C₁₋₄, C₁₋₄, -O-, -S-, -N(R^a)-, -N(R^a)-C(O)-O-, -O-C(O)-N(R^a)-, -N(R^a)-C(O)-N(R^b)-, -O-C(O)-O-, -P(R^a)-, -P(O)(R^a)₂, R^a, R^b

33.

20

34.

20

35.

20

36.

20

ZnS, ZnSe, ZnTe, CdS, CdSe, CdTe, HgS, HgSe, HgTe, AlN, AlP, AlAs, AlSb, GaN, GaP, GaAs, GaSb, GaSe, InN, InP, InAs, InSb, TiN, TiP, TiAs, TiSb, PbS, PbSe PbTe

37.

36

ZnS, ZnSe, ZnTe, CdS, CdSe, CdTe, HgS, HgSe, HgTe, AlN, AlP, AlAs, AlSb, GaN, GaP, GaAs, GaSb, GaSe, InN, InP, InAs, InSb, TiN, TiP, TiAs, TiSb, PbS, PbSe PbTe

38.

1

2

1

2

1 2

39.
38

40.
39

1 2

41.
38

42.
38

2

43.
38

300 nm 400 nm

44.
38

400 nm 700 nm

45.
38

700 nm 1100 nm

46.
38

1100 nm 2500 nm

47.
38

2500 nm

48.
38

TPD

Alq₃

T

AZ

49.

1

2

50.
49

51.
49

52.
49

53.

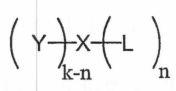
49 ,
2

54.

49 ,

55.

54 ,



, k 2,3 5 , n 1,2,3,4 5 , k-n , X O,S,S=O, SO₂, Se, Se
=O, N, N=O, P, P=O, As As=O , Y L , , , ,
C₂₋₁₂ , , C₁₋₄ , C₂₋₄ , C₂₋₄ , C₁₋₄
1-4 , C₁₋₄ , C₃₋₅ , 3-5 , C₁₋₄
-O-, -S-, -N(R^a)-, -N(R^a)-C(O)-O-, -O-C(O)-N(R^a)-, -N(R^a)-C(O)-N(R^b
)-, -O-C(O)-O-, -P(R^a)- -P(O)(R^a)가 , R^a R^b , , , ,

56.

49 ,

57.

56 , 2

58.

57 ,

59.

57 ,

60.

57 ,

61.

49 , ZnS, ZnSe, ZnTe, CdS, CdSe, CdTe, HgS, HgSe, HgTe, AlN, AlP, AlAs, AlSb, GaN, GaP, GaAs, GaSb, GaSe, InN, InP, InAs, InSb, TiN, TiP, TiAs, TiSb, PbS, PbSe PbTe

62.

61 , ZnS, ZnSe, ZnTe, CdS, CdSe , CdTe, HgS, HgSe, HgTe, AlN, AlP, AlAs, AlSb, GaN, GaP, GaAs, GaSb, GaSe, InN, InP, InAs, InSb, TiN, TiP , TiAs, TiSb, PbS, PbSe PbTe

63.

1 , 2 , , 1 2

1 2 가

64.

63

65.

63

66.

63

67.

63

2

2

68.

63

, 300 nm 400 nm

69.

63

, 400 nm 700 nm

70.

63

, 700 nm 1100 nm

71.

63

, 1100 nm 2500 nm

72.

63

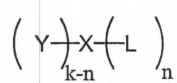
, 2500 nm

73.

63

74.

73



, k 2,3 5 , n 1,2,3,4 5 , k-n , X O,S,S=O, SO₂, Se, Se
 =O, N, N=O, P, P=O, As As=O , Y L , , ,
 C₂₋₁₂ , C₁₋₄ , C₂₋₄ , C₂₋₄ , C₁₋₄
 1-4 , C₁₋₄ , C₃₋₅ , C₁₋₄ , C₃₋₅ , C
 -O-, -S-, -N(R^a)-, -N(R^a)-C(O)-O-, -O-C(O)-N(R^a)-, -N(R^a)-C(O)-N(R^b)
)-, -O-C(O)-O-, -P(R^a)- -P(O)(R^a)가 , R^a R^b , , , ,

75.

63

76.

75 , 1

77.

76 ,

78.

76 ,

79.

76 ,

80.

63 , ZnS, ZnSe, ZnTe, CdS, CdSe, CdTe, HgS, HgSe, HgTe, AlN, AlP, AIAs, AISb, GaN, GaP, GaAs, GaSb, GaSe, InN, InP, InAs, InSb, TiN, TiP, TIAs, TISb, PbS, PbSe PbTe

81.

80 , ZnS, ZnSe, ZnTe, CdS, CdSe , CdTe, HgS, HgSe, HgTe, AlN, AlP, AIAs, AISb, GaN, GaP, GaAs, GaSb, GaSe, InN, InP, InAs, InSb, TiN, TiP , TIAs, TISb, PbS, PbSe PbTe

82.

63 , 10%가

83.

63 , 40 nm

84.

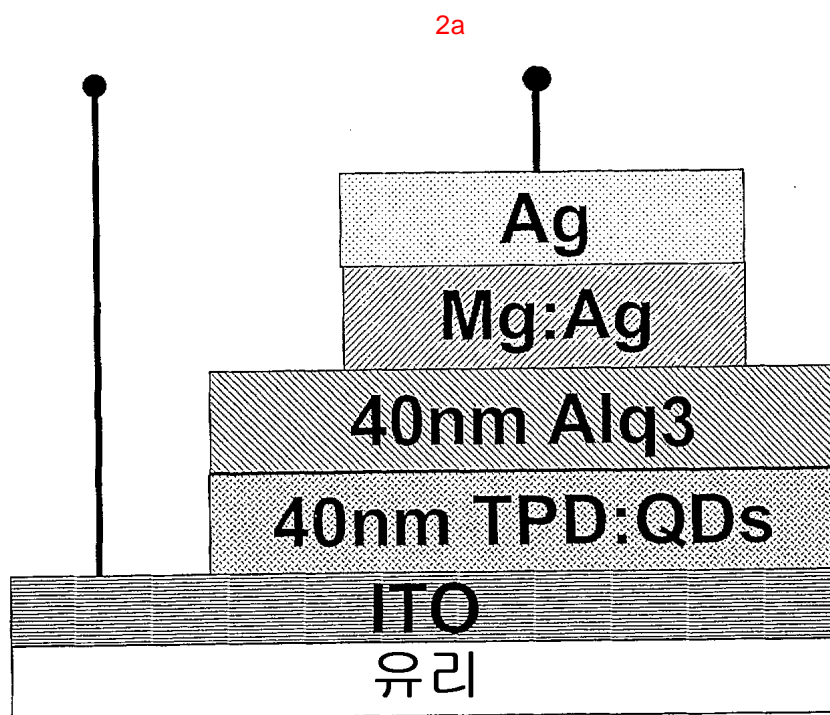
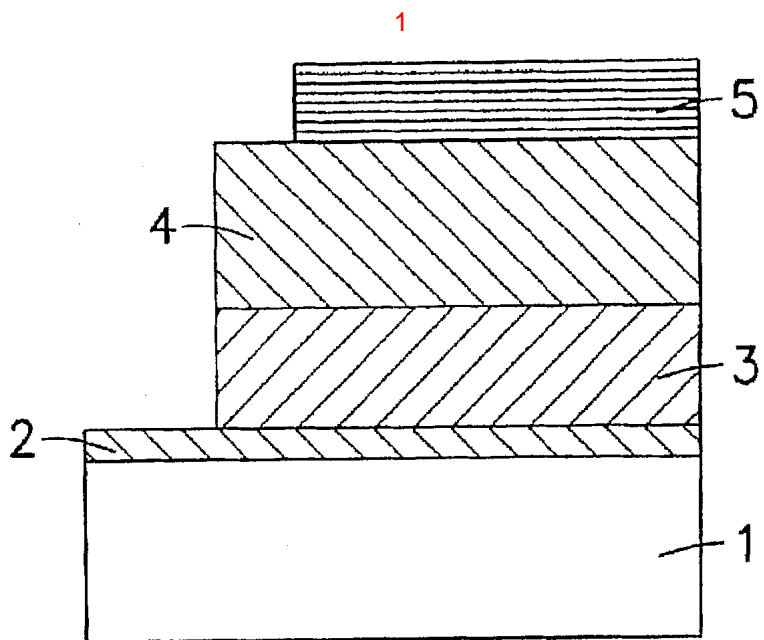
63 , 30 nm

85.

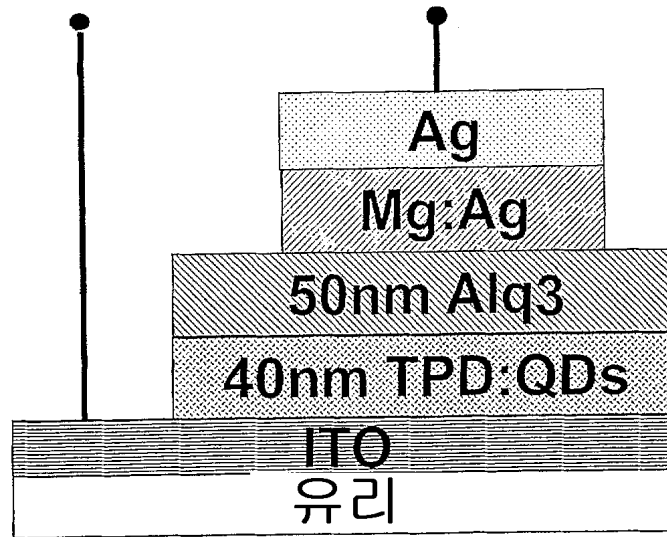
63 , 0.1%

86.

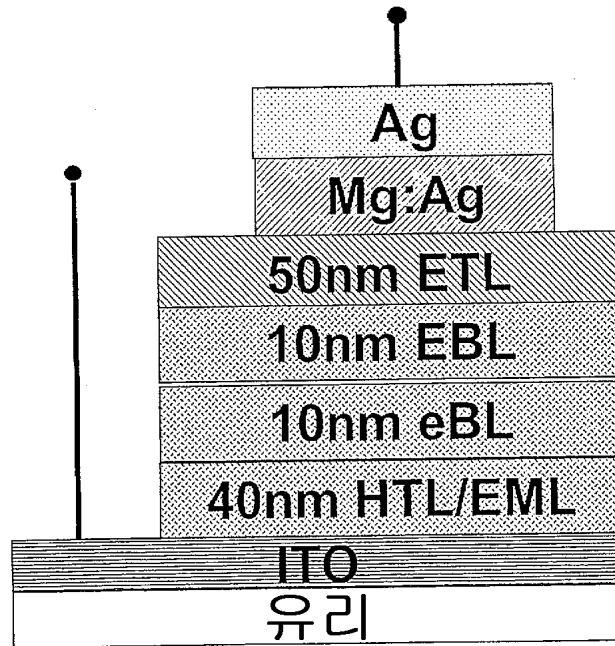
63 , 1.0%

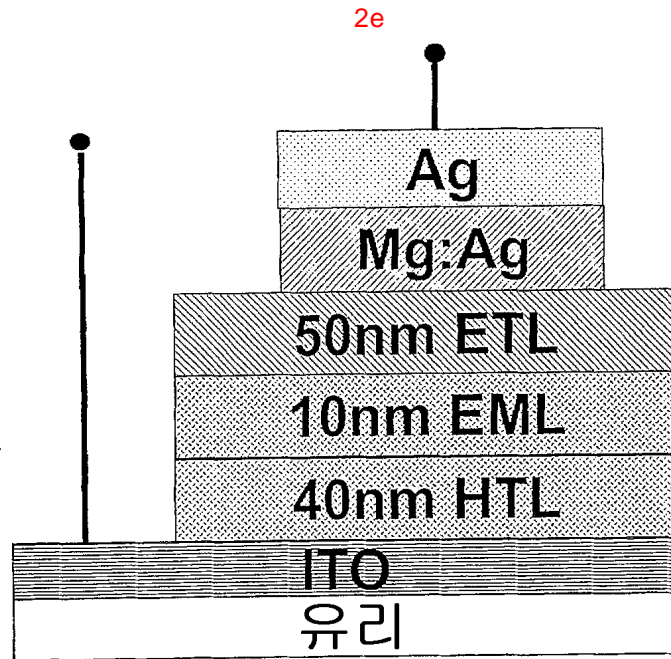
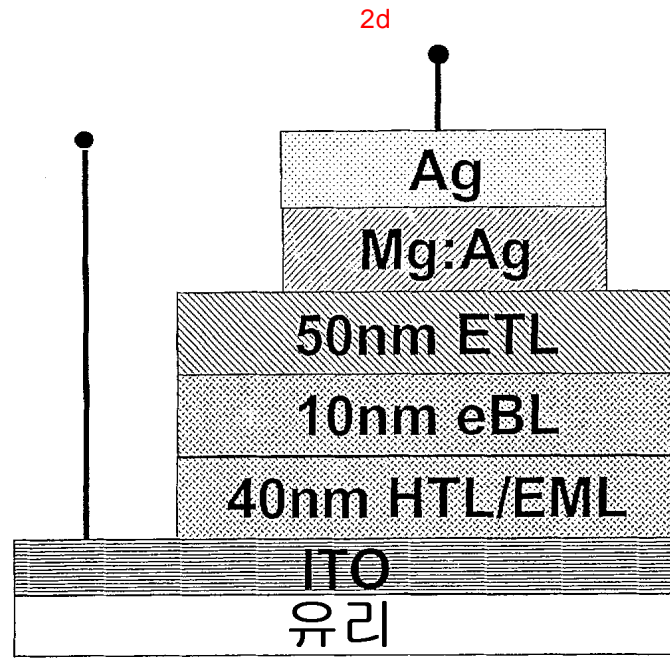


2b

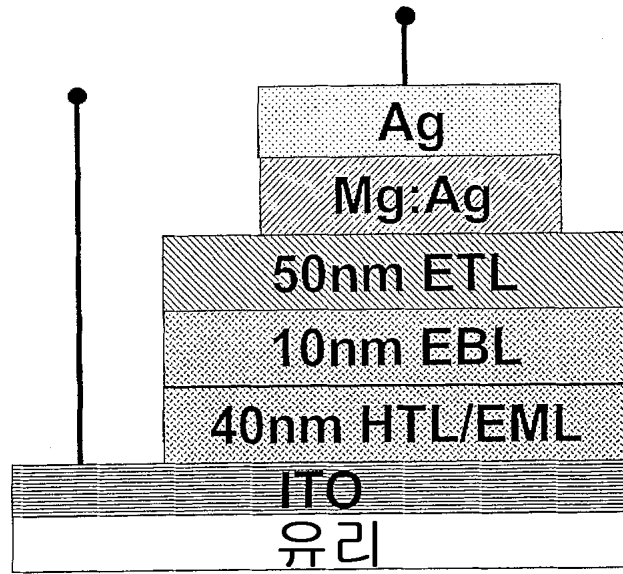


2c

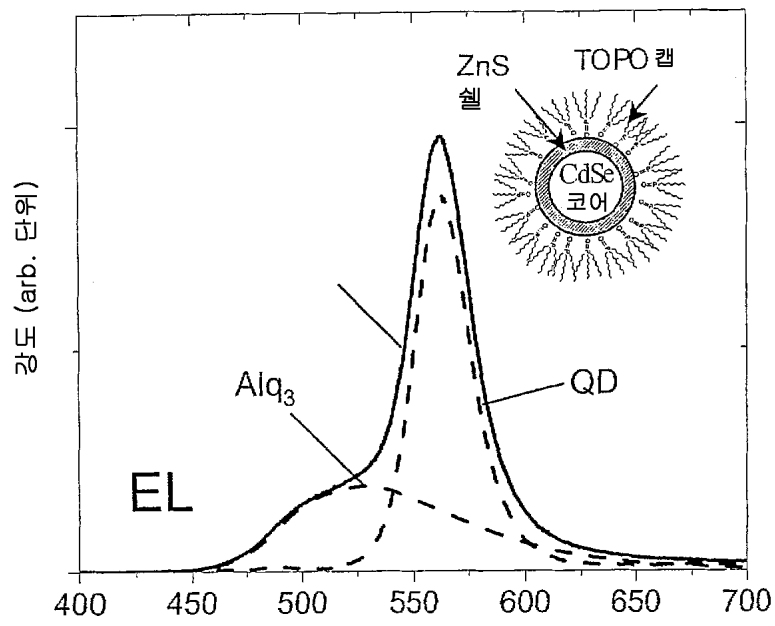




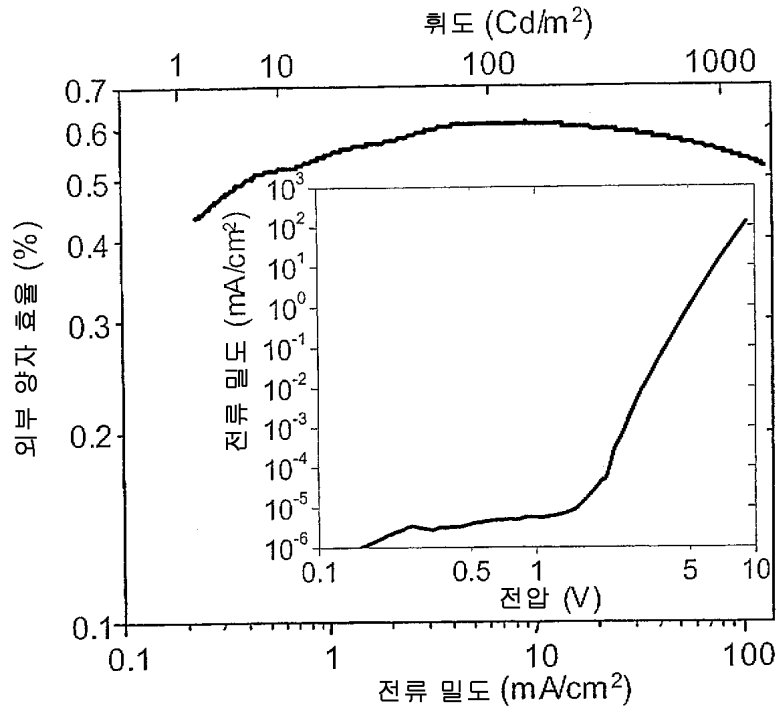
2f



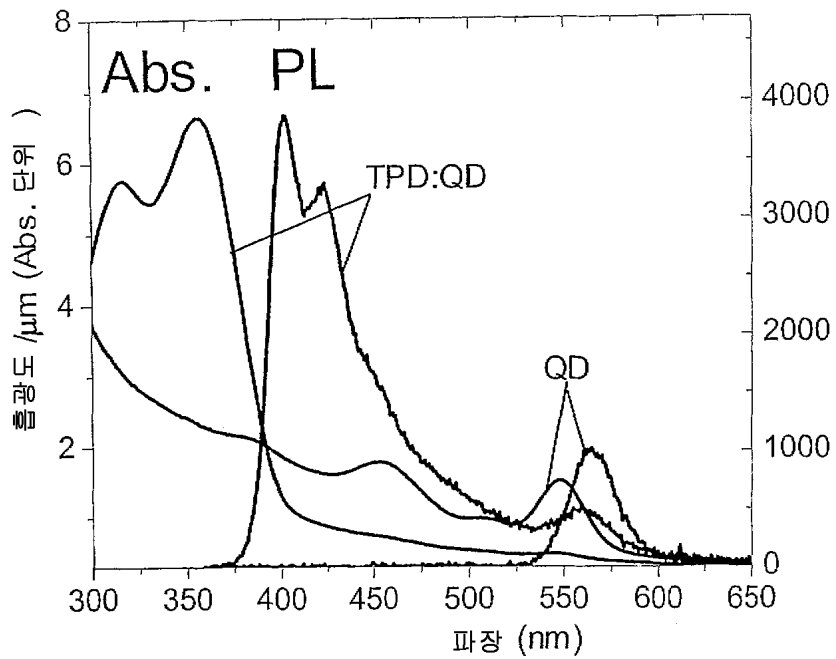
3



4



5



6

