Przezroczyste przewodniki

Adam Gajdziński

FiTKE

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Przezroczyste przewodniki - definicja

Przezroczyste przewodniki

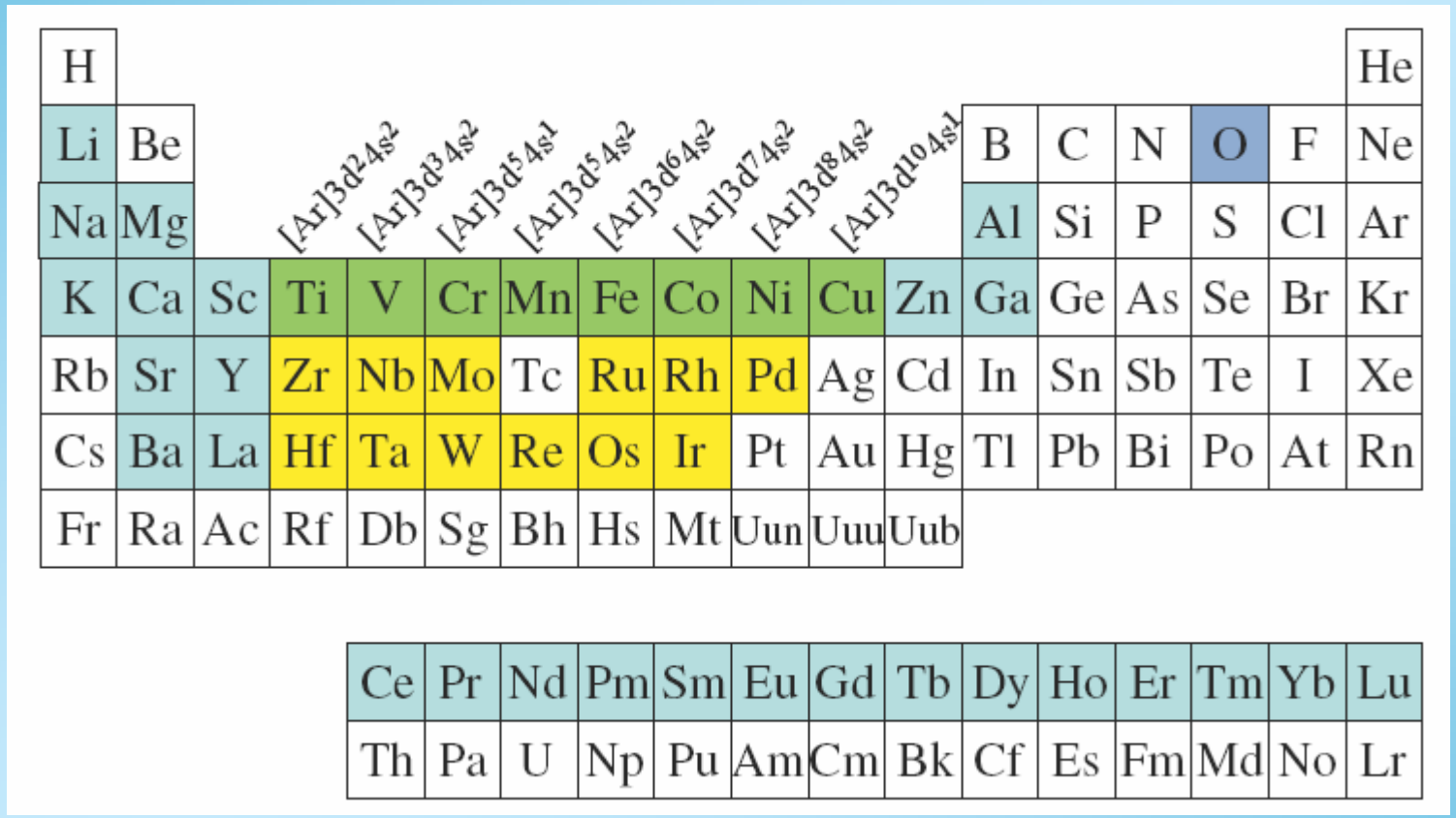
materiały o dużym współczynniku transmisji światła w zakresie widzialnym i jednocześnie przewodzące

Historia

Table I: History of Processes for Making Transparent Conductors.

Materials and Process	Reference
Ag by chemical-bath deposition	Unknown Venetian
SnO_2:Sb by spray pyrolysis	J.M. Mochel (Corning), 1947[1]
SnO_2:Cl by spray pyrolysis	H.A. McMaster (Libbey-Owens-Ford), 1947[2]
SnO_2:F by spray pyrolysis	W.O. Lytle and A.E. Junge (PPG), 1951[3]
In_2O_3:Sn by spray pyrolysis	J.M. Mochel (Corning), 1951[4]
In_2O_3:Sn by sputtering	L. Holland and G. Siddall, 1955[5]
SnO_2:Sb by CVD	H.F. Dates and J.K. Davis (Corning), 1967[6]
Cd_2SnO_4 by sputtering	A.J. Nozik (American Cyanamid), 1974[7]
Cd_2SnO_4 by spray pyrolysis	A.J. Nozik and G. Haacke (American Cyanamid), 1976[8]
SnO_2:F by CVD	R.G. Gordon (Harvard), 1979[9]
TiN by CVD	S.R. Kurtz and R.G. Gordon (Harvard), 1986[10]
ZnO:In by spray pyrolysis	S. Major et al. (Ind. Inst. Tech.), 1984[11]
ZnO:Al by sputtering	T. Minami et al. (Kanazawa),1984[12]
ZnO:In by sputtering	S.N. Qiu et al. (McGill), 1987[13]
ZnO:B by CVD	P.S. Vijayakumar et al. (Arco Solar), 1988[14]
ZnO:Ga by sputtering	B.H. Choi et al. (KAIST), 1990[15]
ZnO:F by CVD	J. Hu and R.G. Gordon (Harvard), 1991[16]
ZnO:Al by CVD	J. Hu and R.G. Gordon (Harvard), 1992[17]
ZnO:Ga by CVD	J. Hu and R.G. Gordon (Harvard), 1992[18]
ZnO:In by CVD	J. Hu and R.G. Gordon (Harvard), 1993[19]
Zn_2SnO_4 by sputtering	H. Enoki et al. (Tohoku), 1992[20]
$ZnSnO_3$ by sputtering	T. Minami et al. (Kanazawa), 1994[21]
Cd_2SnO_4 by pulsed laser deposition	J.M. McGraw et al. (Colorado School of Mines and NREL), 1995[22]

Historia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Pa
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Pu
Am
Cm
Bk
Cf
Es
Fm
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No
Lr

Główne zastosowanie

- energooszczędne okna
- ogniwa fotowoltaiczne
- inteligentne okna
- kserokopiarki
- wyświetlacze
- inne

Efektywność przezroczystyczh przewodników

$$\sigma/\alpha = -\{R_s \ln(T + R)\}^{-1}$$

Table II: Figures of Merit σ/α for Some Transparent Conductors.

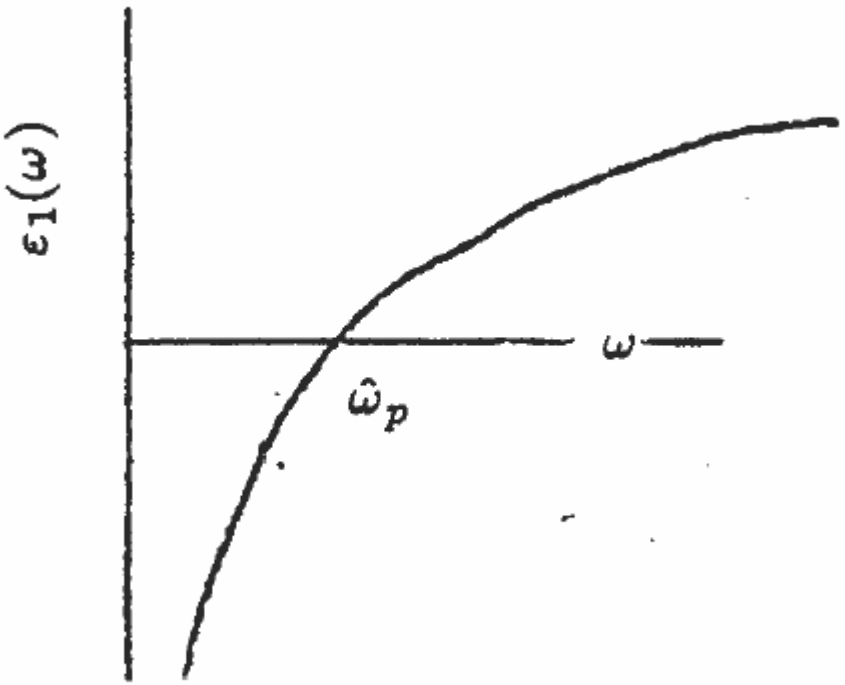
Material	Sheet Resistance ($\Omega/\square$)	Visible Absorption Coefficient α	Figure of Merit (Ω^{-1})
ZnO:F	5	0.03	7
Cd_2SnO_4	7.2	0.02	7
ZnO:Al	3.8	0.05	5
In_2O_3:Sn	6	0.04	4
SnO_2:F	8	0.04	3
ZnO:Ga	3	0.12	3
ZnO:B	8	0.06	2
SnO_2:Sb	20	0.12	0.4
ZnO:In	20	0.20	0.2

Efektywność graniczna

$$\sigma/\alpha = 4\pi^2\varepsilon_0 c^3 n(m^*\mu)^2\lambda^{-2}e^{-2},$$

Efektywność graniczna

$$\omega_p^2 = \frac{Ne^2}{\epsilon_{opt}\epsilon_0 m^*},$$



Idealny przezroczysty przewodnik

Table IV: Work Functions of Some Transparent Conductors.

Material	Work Function (eV)	Electron Concentration (cm^{-3})
ZnO:F	4.2	2×10^{20}
ZnO	4.5	7×10^{19}
In_2O_3:Sn	4.8	$>10^{20}$
SnO_2:F	4.9	4×10^{20}
$ZnSnO_3$	5.3	6×10^{19}

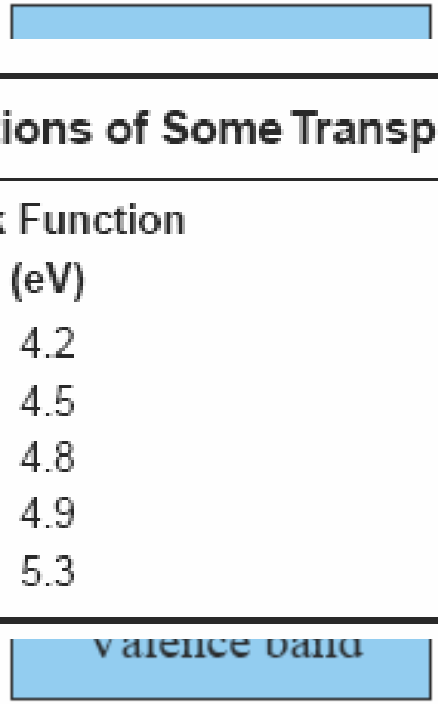


FIG. 3. The schematic band structure of "ideal" TCO: $\Delta_w < 1.8$ eV, $\Delta_v > 3.1$ eV and $\Delta_c > 3.1$ eV provide 100% transparency in the visible range.

Dobór materiału do zastosowań

Table VIII: Choice of Transparent Conductors.

Property	Material
Highest transparency	ZnO:F, Cd_2SnO_4
Highest conductivity	In_2O_3:Sn
Lowest plasma frequency	SnO_2:F, ZnO:F
Highest plasma frequency	Ag, TiN, In_2O_3:Sn
Highest work function, best contact to *p*-Si	SnO_2:F, $ZnSnO_3$
Lowest work function, best contact to *n*-Si	ZnO:F
Best thermal stability	SnO_2:F, TiN, Cd_2SnO_4
Best mechanical durability	TiN, SnO_2:F
Best chemical durability	SnO_2:F
Easiest to etch	ZnO:F, TiN
Best resistance to H plasmas	ZnO:F
Lowest deposition temperature	In_2O_3:Sn, ZnO:B, Ag
Least toxic	ZnO:F, SnO_2:F
Lowest cost	SnO_2:F

Dobór materiału do zastosowań

- „Criteria for Choosing Transparent Conductors”, Roy G. Gordon
- „Physics of Transition Metal Oxides”
- „Optical Properties of Solids”, M. S. Dresselhaus
- „Combining high conductivity with complete optical transparency”, J. E. Medvedeva and A. J. Freeman

bibliografia: