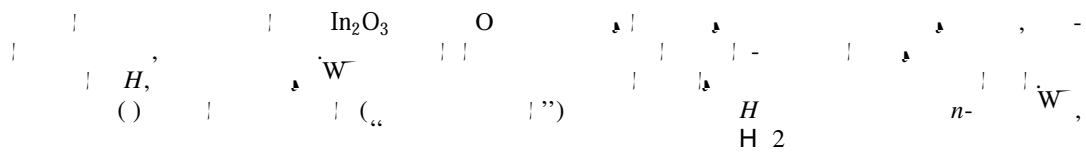
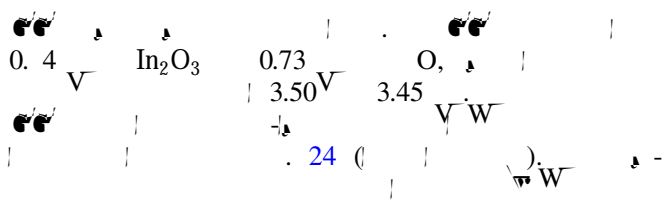
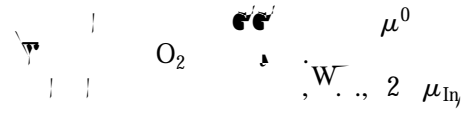


# Dopability, Intrinsic Conductivity, and Nonstoichiometry of Transparent Conducting Oxides

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(7/2006, 23/2007)



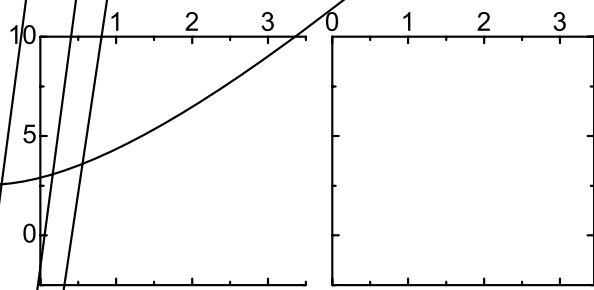
3  $\mu$



$$H_D, E_F, \mu' \quad -E_D \quad E_H, qE_F, \sum \pm \mu^0, \mu'$$

$$E_D, E_H, q$$

$$\mu_O \quad \mu_{In}, \mu_{Zn}, \mu_{Sn}, \mu_{Al}$$



$(E_F < E_C)$   
 $V_{Zn}$   
 13,15  
 $E_F$   
 $M'$   
 $n \approx 10^{17} \text{ cm}^{-3}$   
 $T_g = 1423 \text{ K}$  31  
 $V_{Zn}$   
 $c. V_{Zn} \approx 2 \times 10^{15} \text{ cm}^{-3}$   
 $p. O_2 \approx 1 \text{ atm}$   
 Large eqilibri m o gen de cienc .  $In_2O_3$   
 $(\approx 1\%) O$

4,8  
 $V_O$   
 $In_2O_3$   
 $O$  ( . 1) .  $In_2O_3$   
 $2 \times 10^{20} \text{ cm}^{-3}$  0.4%  
 $T = 1673 \text{ K}$  ( . 1) ,  
 $O$  1% . 4  
 $10^{19} \text{ cm}^{-3}$  (0.1%)  $T = 1373 \text{ K}$  ( . 1)  $V_O$  4 x  
 . 5 .  $V_O$   
 $c. V_O \approx 10^{17} \text{ cm}^{-3}$   
 $O$  8 ,  
 $O$  32 .

*E cited O acancies can lead to (persistent) photocon-*  
*d cti it .*  
 $V_O$  14 ,  
 $V_O^0$

$a_1^2$   
 $a_1^0$   
 $In_2O_3$   $M'$  Y6 .  
 20 ,  $a_1^0$   
 $(V_O)$   
 $In_2O_3$   $O$  .  
 $E_i$

*Coe istence of coloration and cond cti it .*  
 $In_2O_3$  ( ) 4  
 $O$  ( ) 5 ,  
 $(\dots)$   
 $V_O^0$   $V_O$  ,  $e$   
 $V_O^0$   $V_O$  ,  $e$   $V_O$   
 $1.8$   $1.6$   $In_2O_3$   
 $2.8$   $2.4$   $V$   $O$  16 .

1100 4 ,  
 $(\dots)$  1) .  
*E trinsic donors do lead to degenerate doping.*  
 .3,  $Sn_{In}$   $In_2O_3$   $Al_{Zn}$   $O$   
 $H$   $E_F$   
 $In_2O_3$  ,  $W$  1%  
 $(O_2)$   
 $(\dots)$  2) .  
 $(T = 1073 \text{ K})$  30 ,  
 $p. O_2 \approx 10^6 \text{ atm}$  30  
 $p. O_2^{1/8}$  ( . 2) .  
 .3 ,  
 $p. O_2$  ,  
 $E_F$  1%  
 $M'$   $O$  ,  $V$   
 $(\dots)$  2) .  
 $p. O_2$  ,  
 $V_{Zn}$   
 $10^6 \text{ atm}$  ( . 2) ,  
 $p. O_2^{1/4}$   
 $p. O_2 \approx$

$V_O$  ( $\cdot 1$ ),  
 $\text{In}_2\text{O}_3$  O, 33  
 $\text{In}_2\text{O}_3$ .  
 $10^{17}$ ,  $10^{19} \text{ cm}^{-3}$  4,5,7