In in ic *DX* Cen e in Te na Chalco i e Semicond c o

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I III-V II-VI W I-III-VI$_2$ CuInSe$_2$ CuGaSe$_2$, . T. CuInSe$_2$- G .

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VI F I G C . B I-III-VI$_2$ II-VI Z S Z O , F F II-VI . A ZnO CdS Cu(In, Ga)Se$_2$ [5], . S In$_{Cu}$ Ga$_{Cu}$ Cu [5,10], HE

CuInSe$_2$ CuGaSe$_2$, *intrinsic* . T , C (I) G (III) CuGaSe$_2$, , F I CuInSe$_2$-CuGaSe$_2$ [5], T I-III-VI$_2$: () I CuInSe$_2$ [6 8] I - -C (In$_{Cu}$) CuInSe$_2$ CuGaSe$_2$ C - Cu [6,7,9], (,) (In$_{Cu}$-2 Cu) [10] , (,) [11,12], ( ) [13]. W *intrinsic* In$_{Cu}^{2+}$ Ga$_{Cu}^{2+}$ CuInSe$_2$ CuGaSe$_2$

R . [7]. I LDA (VBM) LDA + [13], (CBM). I R . [16].

The Frenkel-pair character of the center.— T. II-VI Z S :G -III Ga$_{Zn}$ [1̄ 1 1̄] [17]. T , F . S Ga$_{Cu}$ CuGaSe$_2$ In$_{Cu}$ CuInSe$_2$ Z S CuGaSe$_2$. (N Z S CuGaSe$_2$ Z “ ” C G .) I ,

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F (F . 1), . ., $Ga^{+}_{Zn} + 2 \rightarrow Ga^{-} = (Ga^{+}\text{-}/\,^{2-}_{Zn})$ Z S , $Ga^{2+}_{Cu} + 2 \rightarrow Ga^{0} = (Ga^{+}\text{-}/\,^{-}_{Cu})$ $CuGaSe_2$.

I G - Ga^{+} Z S [F . 1( ) 1( )],

single-particle *ε*
(F . 2). C F

ε − , , F. 2). B , || PL, , -
w , || || . ( ) T , , -
In^0 → In$^+$ + , -
| ($_{abs}$ = 0.81 eV). ( ) T , , ,