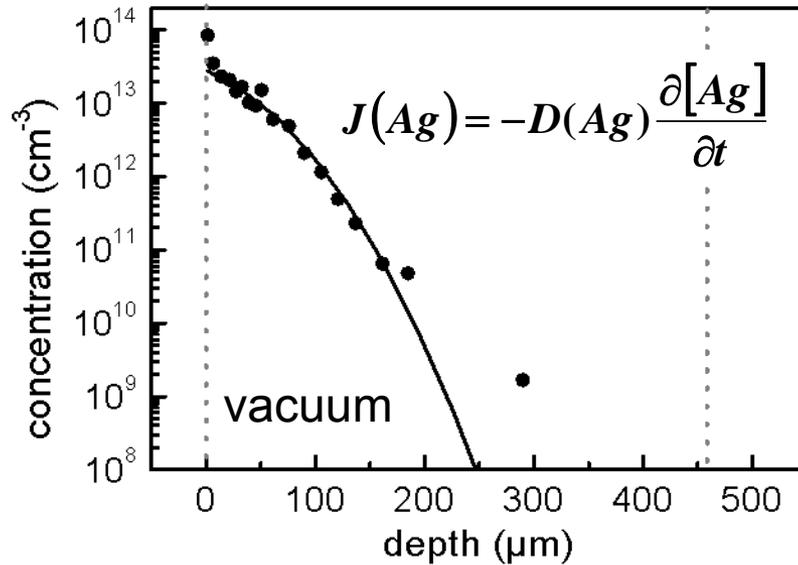


Diffusion behaviour of short lived isotopes in II-VI semiconductors

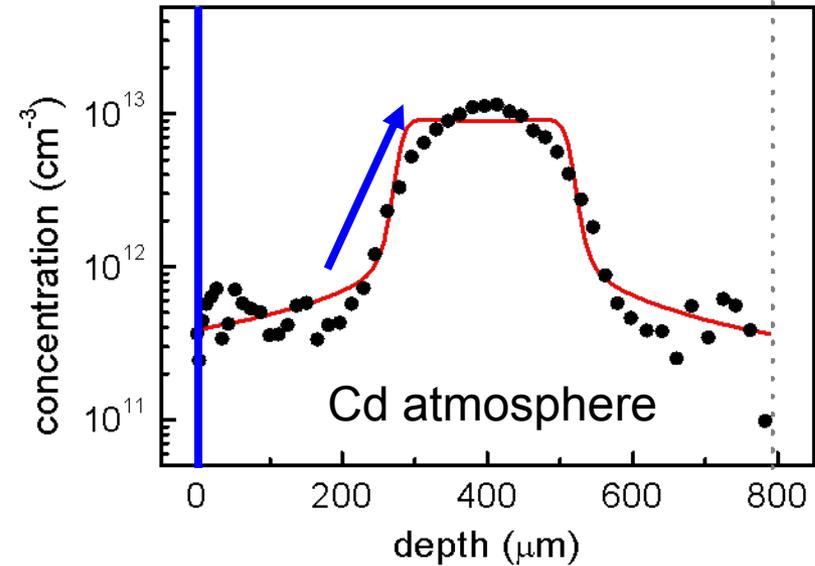
H. Wolf¹, F. Wagner¹, J. Kronenberg¹, H. Wolf¹, Th. Wichert¹, K. Johnston¹
and the ISOLDE Collaboration

¹) *Technische Physik, Universität des Saarlandes, D-66123 Saarbrücken, Germany*

Ag in CdTe: 550K, 30 min

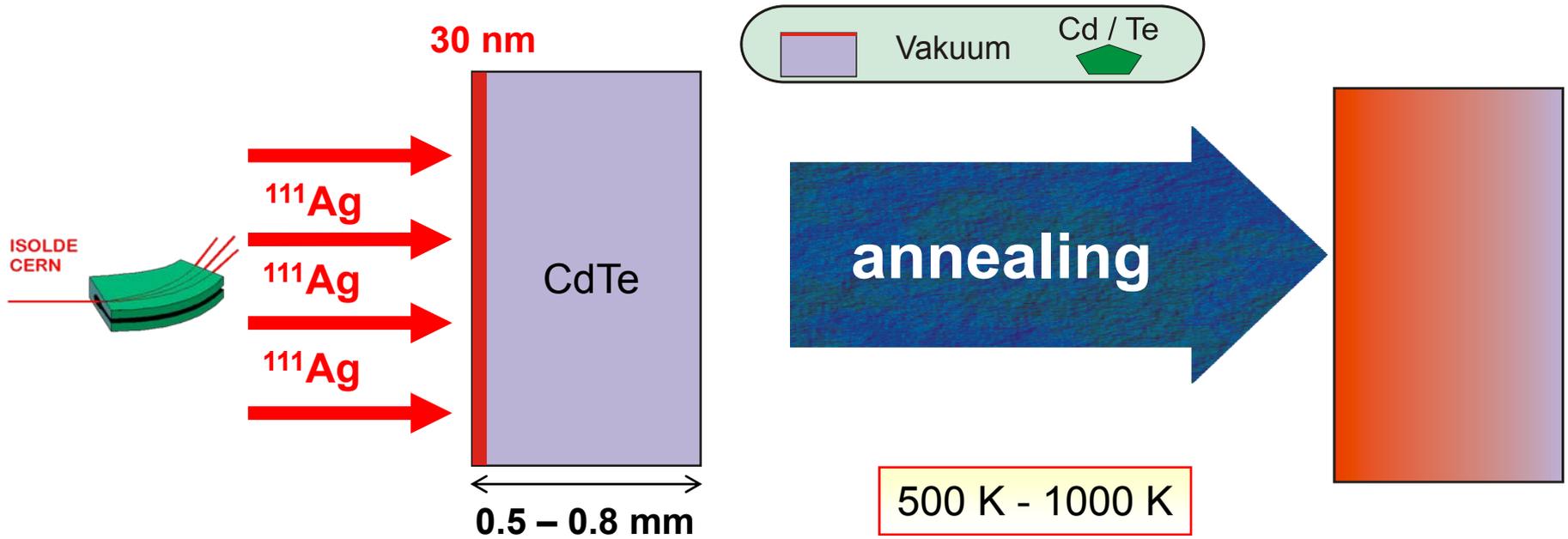


Ag in CdTe: 828K, 60 min



- Up hill diffusion
- Not explainable by fick's laws

radiotracer technique

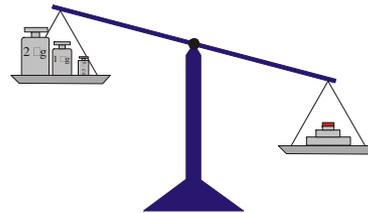
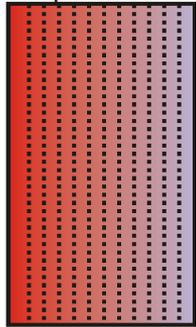


radiotracer technique



mechanical polishing

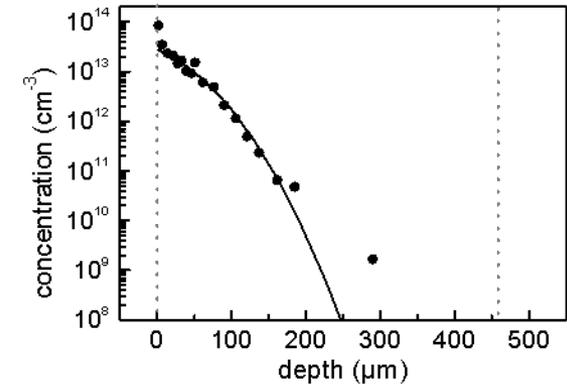
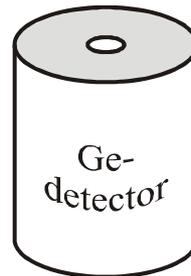
1-40 μm



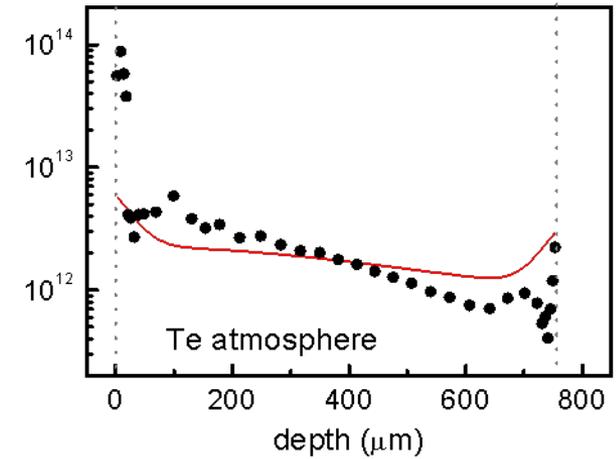
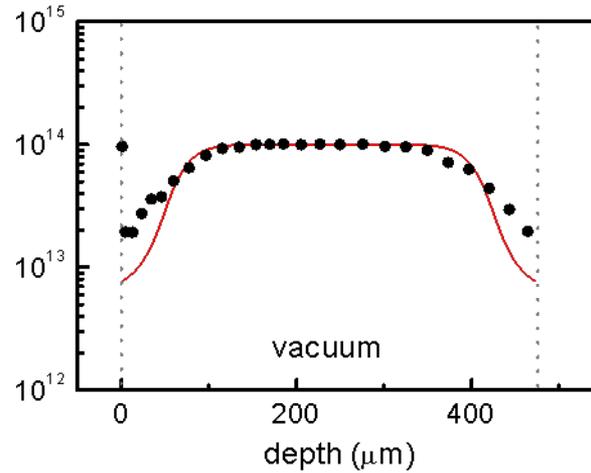
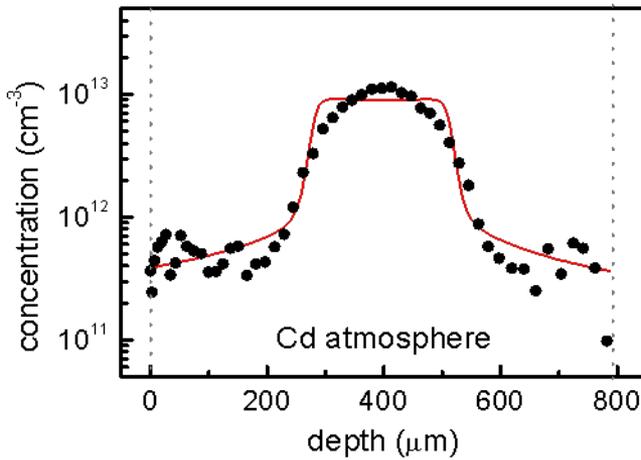
weighing



activity

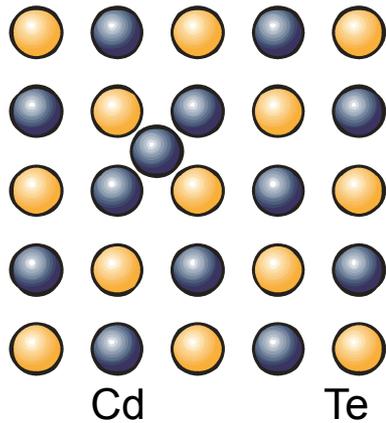


Ag in CdTe: 828K, 60 min

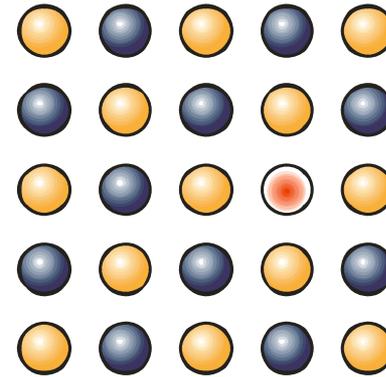


**Up hill diffusion
What can we learn?**

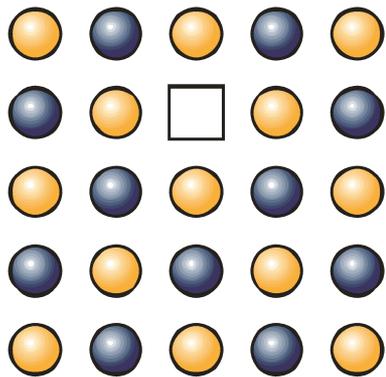
Workshop 2007



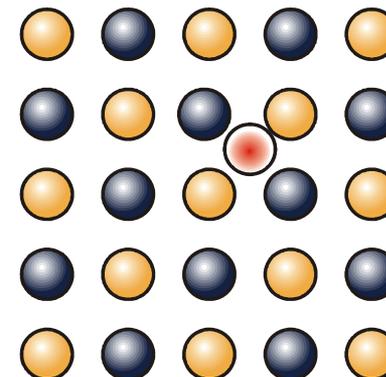
- Interstitial Cd
- Donator (Cd_i^{++})



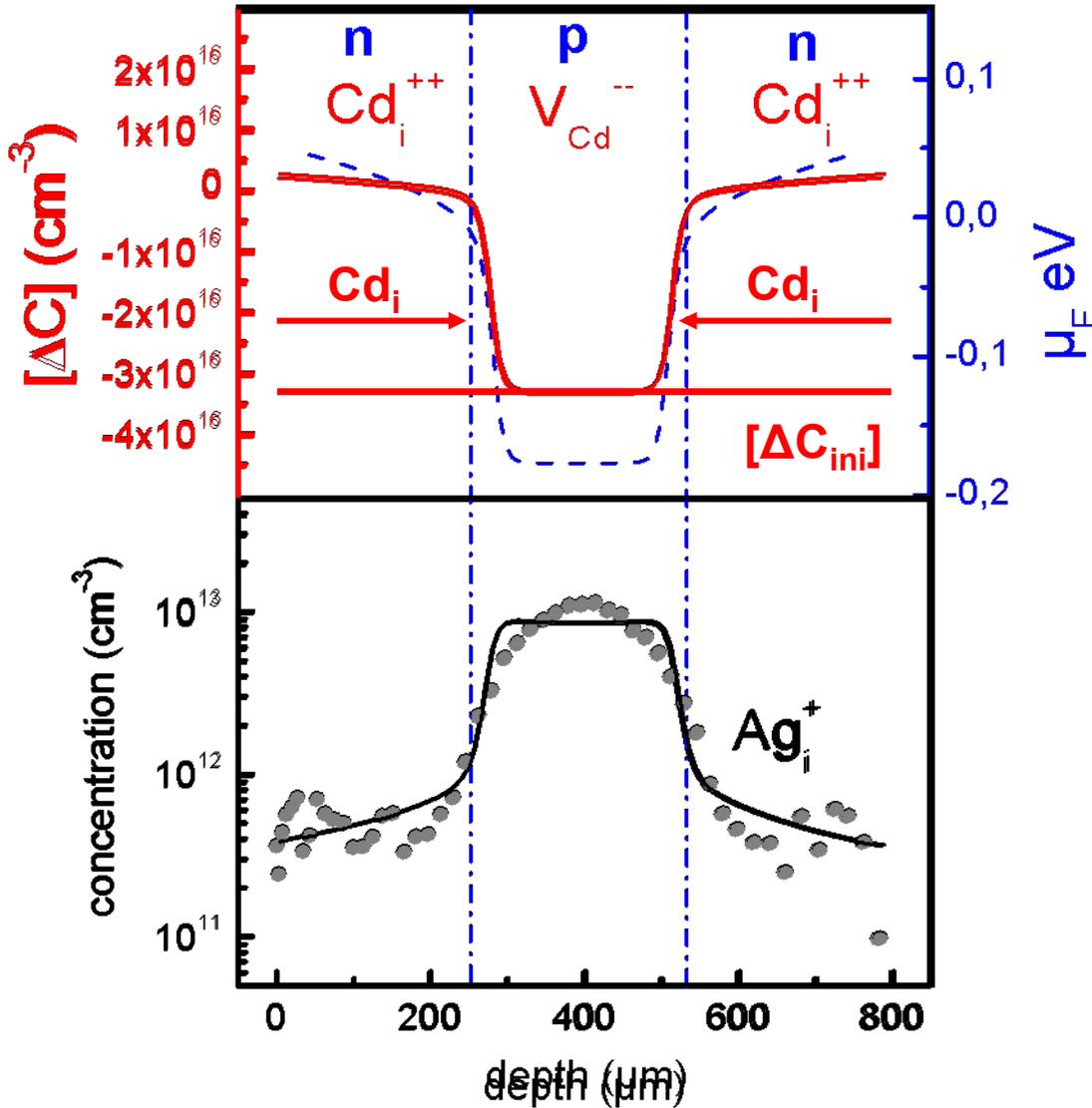
- Substitutionell Ag
- Acceptor (Ag_{Cd}^-)



- Cd vacancy
- Acceptor ($\text{V}_{\text{Cd}}^{--}$)



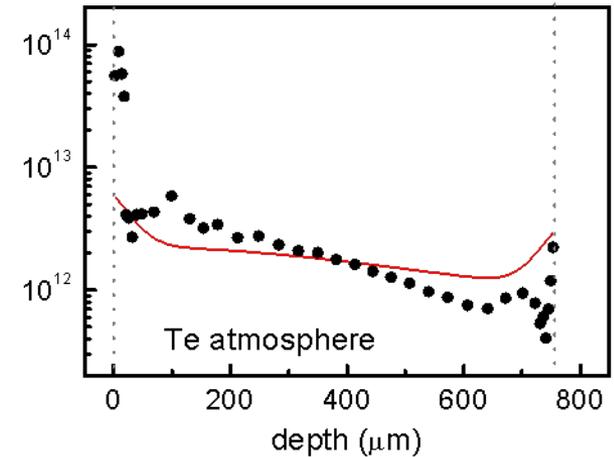
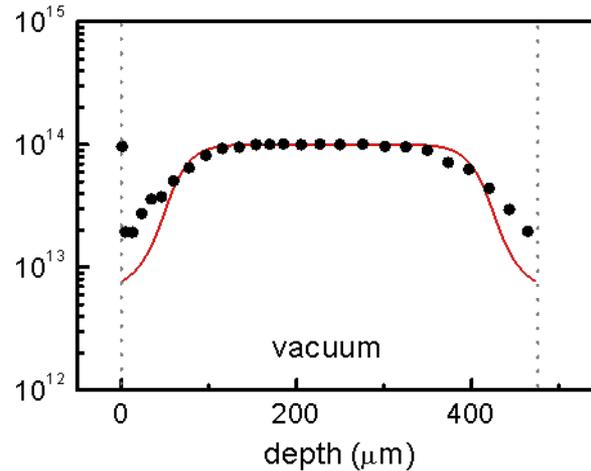
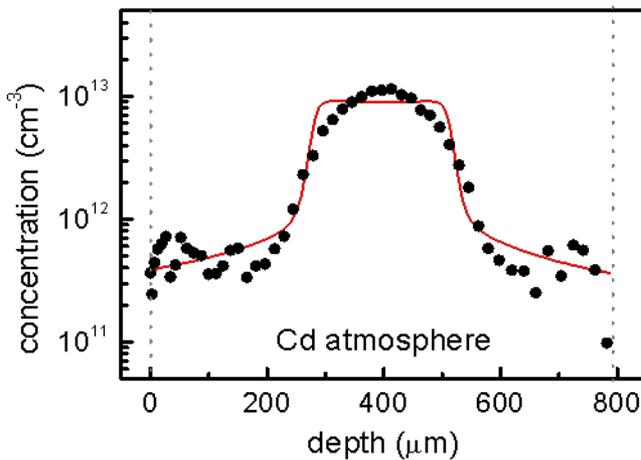
- Interstitial Ag
- Donator (Ag_i^+)



Cd-atmosphere (828 K 60 min)

- Cd-atmosphere: Cd_i in diffusion
➤ $[\Delta C] = [Cd_i] - [V_{Cd}]$
- $[\Delta C]$ determines μ_F
- $[Ag] = [Ag_i^+]$
- Ag_i⁺ behaves like h⁺
- Ag profile reflect μ_F und $[\Delta C]$

Ag in CdTe: 828K, 60 min



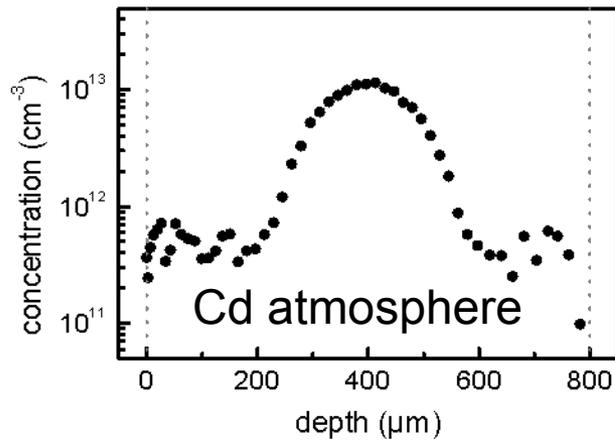
- Information about:
- Diffusion coefficients
 - Formation energies
 - Ionizations energies

Ag in different semiconductors



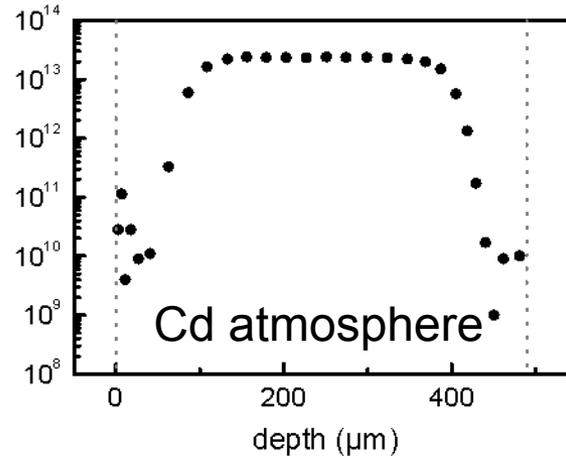
CdTe

828K, 60 min



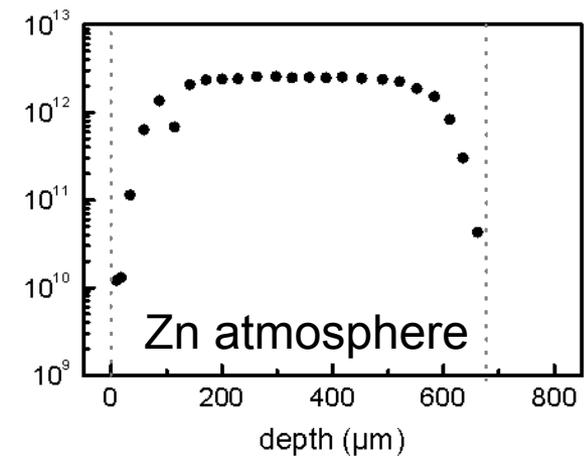
Cd_{0.96}Zn_{0.04}Te

828K, 60 min



ZnTe

928K, 24 h



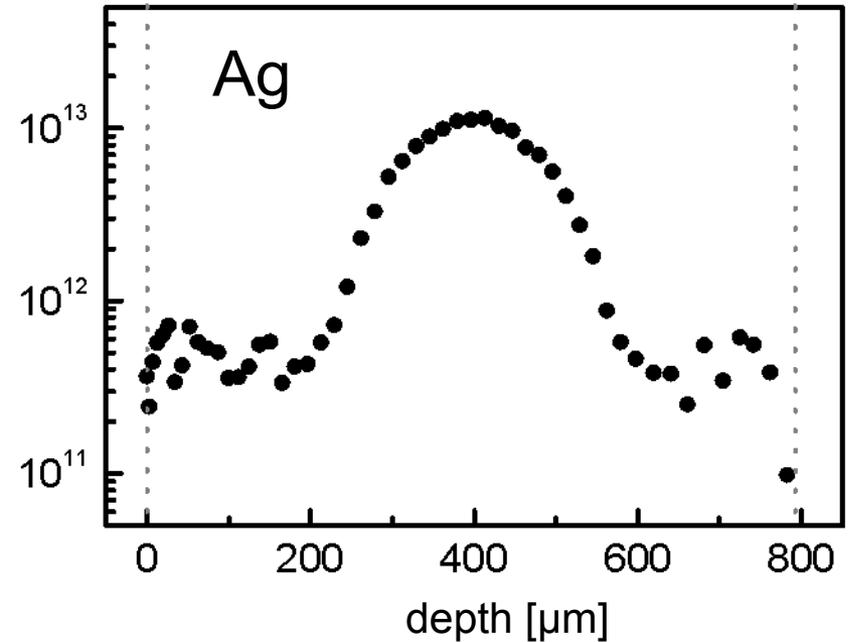
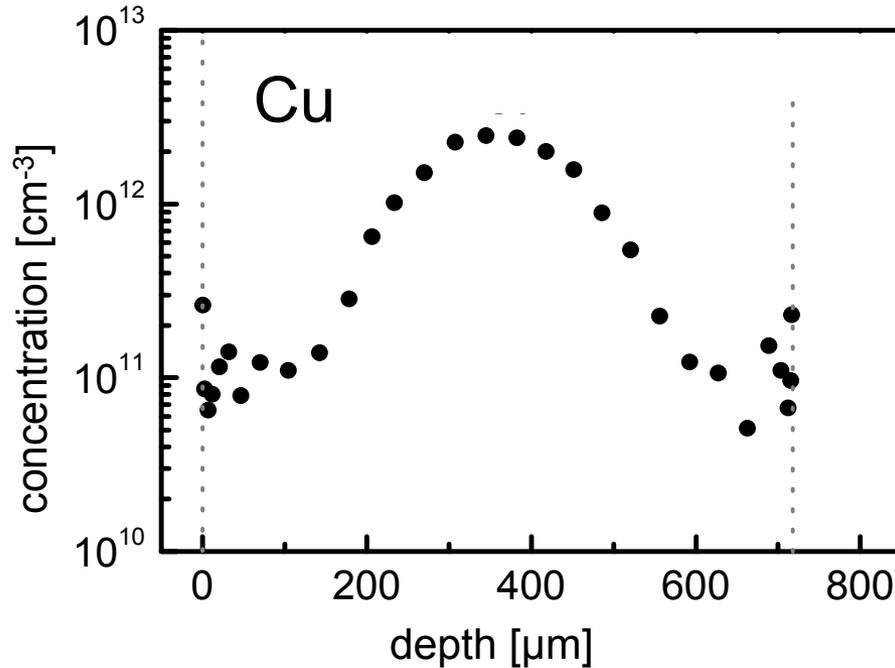
Comparable behavior of Ag in different II-VI semiconductors

Ia																		VIII					
H 1																	He 2						
IIa																		IIIa	IVa	Va	VIIa	VIIa	Ne
Li 3	Be 4																	B 5	C 6	N 7	O 8	F 9	Ne 10
Na		Mg	IIIb	IVb	Vb	VIb	VIIb	VIII				Ib	IIb	Al	Si	P	S	Cl	Ar				
11	12																	13	14	15	16	17	18
K 19	Ca 20	Sc 21	Ti 22	V 23	Cr 24	Mn 25	Fe 26	Co 27	Ni 28	Cu 29	Zn 30	Ga 31	Ge 32	As 33	Se 34	Br 35	Kr 36						
Rb 37	Sr 38	Y 39	Zr 40	Nb 41	Mo 42	Tc 43	Ru 44	Rh 45	Pd 46	Ag 47	Cd 48	In 49	Sn 50	Sb 51	Te 52	I 53	Xe 54						
Cs 55	Ba 56	La 57	Hf 72	Ta 73	W 74	Re 75	Os 76	Ir 77	Pt 78	Au 79	Hg 80	Tl 81	Pb 82	Bi 83									
La		Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu								
57	58	59	60	61	62	63	64	65	66	67	68	69	70	71									

Comparison Ag and Cu in CdTe



Cd atmosphere, 828 K, 60 min



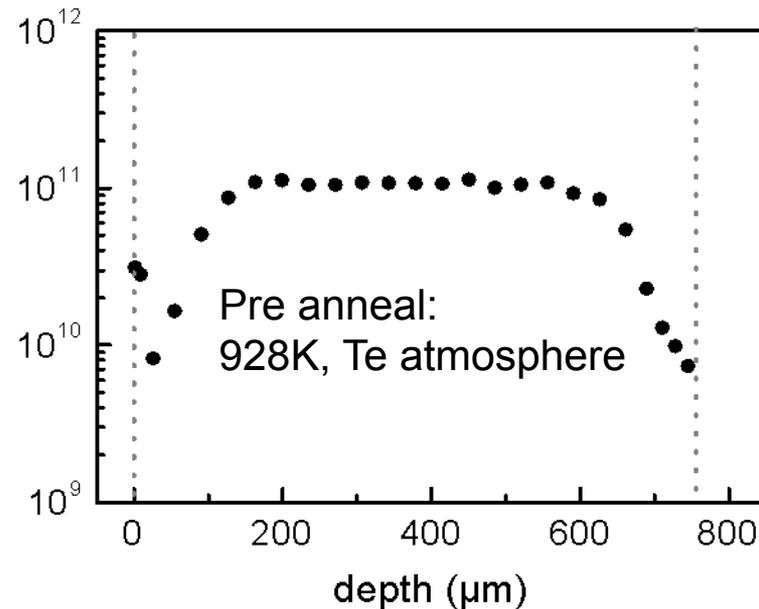
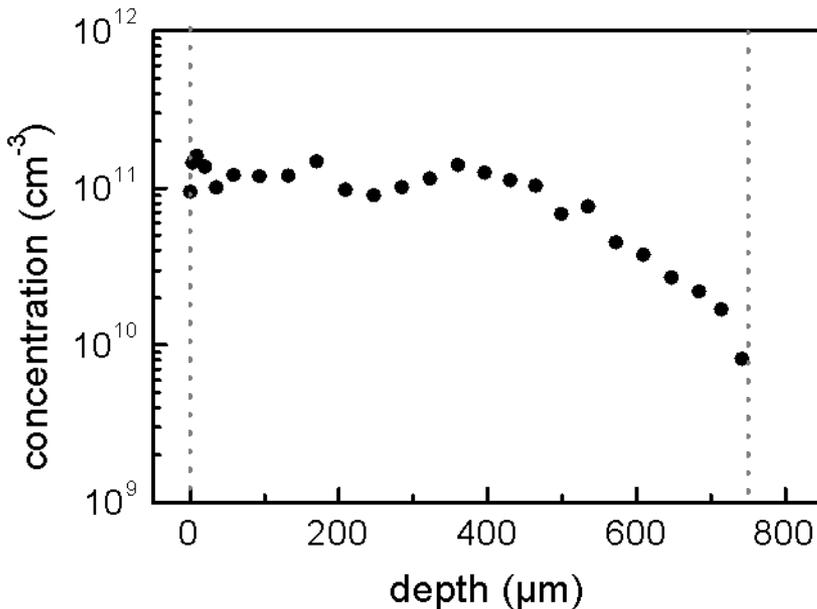
Comparable behavior of Ag and Cu

Ia																		VIII					
H 1																	He 2						
IIa																		IIIa	IVa	Va	VIIa	VIIa	Ne
Li 3	Be 4																	B 5	C 6	N 7	O 8	F 9	Ne 10
Na		Mg	IIIb	IVb	Vb	VIb	VIIb	VIII			Ib	IIb	Al	Si	P	S	Cl	Ar					
11	12																	13	14	15	16	17	18
K 19	Ca 20	Sc 21	Ti 22	V 23	Cr 24	Mn 25	Fe 26	Co 27	Ni 28	Cu 29	Zn 30	Ga 31	Ge 32	As 33	Se 34	Br 35	Kr 36						
Rb 37	Sr 38	Y 39	Zr 40	Nb 41	Mo 42	Tc 43	Ru 44	Rh 45	Pd 46	Ag 47	Cd 48	In 49	Sn 50	Sb 51	Te 52	I 53	Xe 54						
Cs 55	Ba 56	La 57	Hf 72	Ta 73	W 74	Re 75	Os 76	Ir 77	Pt 78	Au 79	Hg 80	Tl 81	Pb 82	Bi 83									
La 57		Ce 58	Pr 59	Nd 60	Pm 61	Sm 62	Eu 63	Gd 64	Tb 65	Dy 66	Ho 67	Er 68	Tm 69	Yb 70	Lu 71								

Au diffusion in CdZnTe



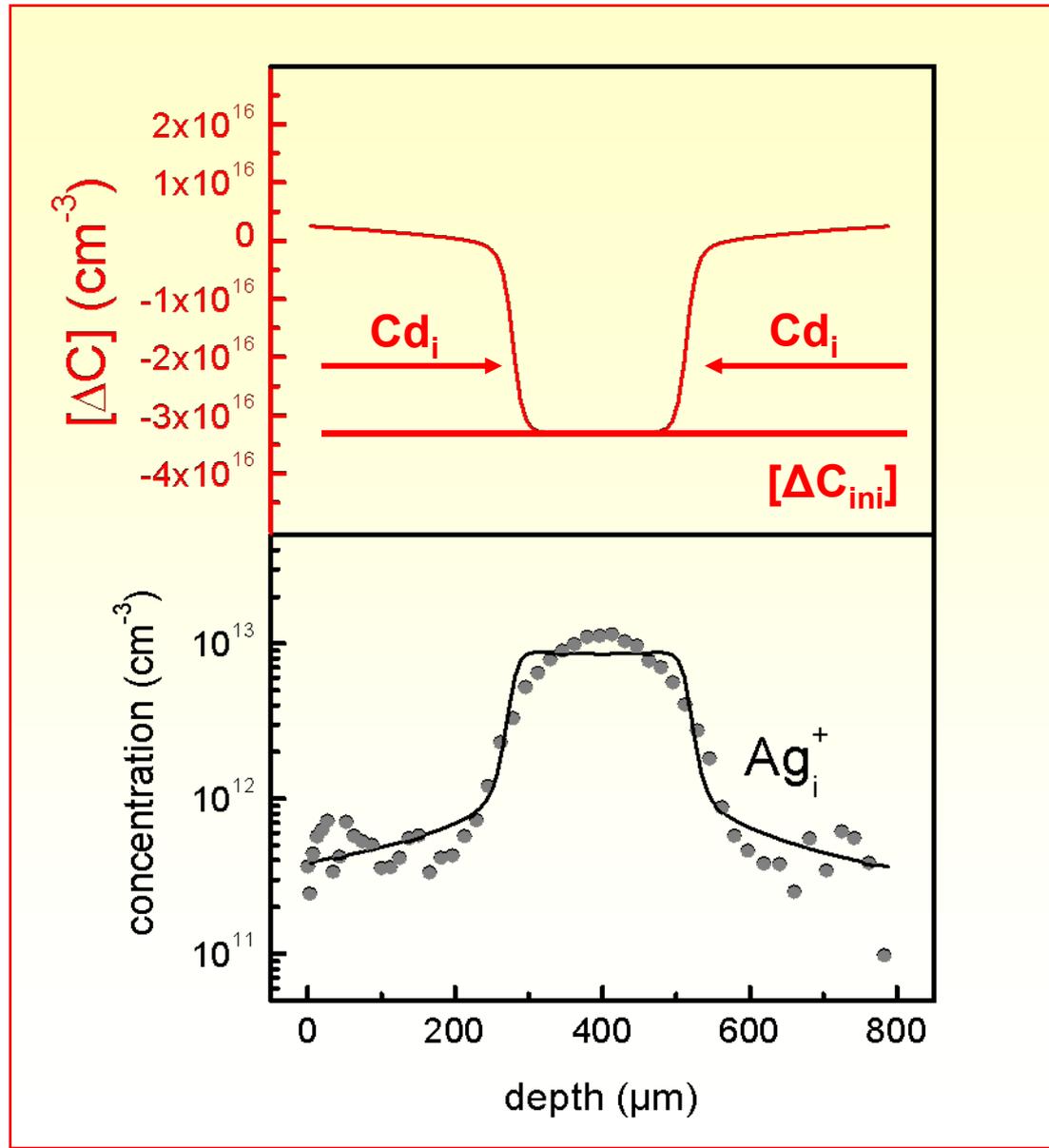
CdZnTe: 828K, 60 min, Cd atmosphere



- $D(\text{Au}) \gg D(\text{Teramoto et al.}) \approx 1 \mu\text{m}$
- No uphill diffusion?

I. Teramoto and S. Takayanagi, J. Phys. Soc. Jpn. 17 (1962) 1137.

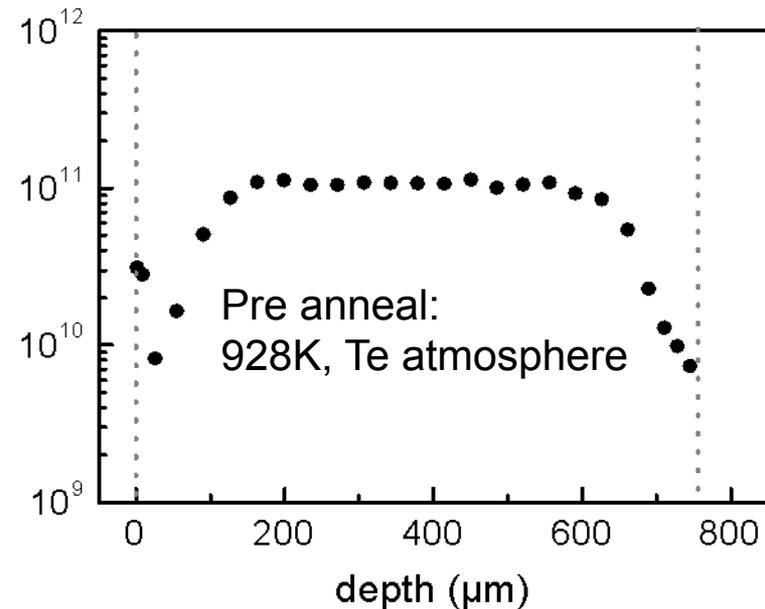
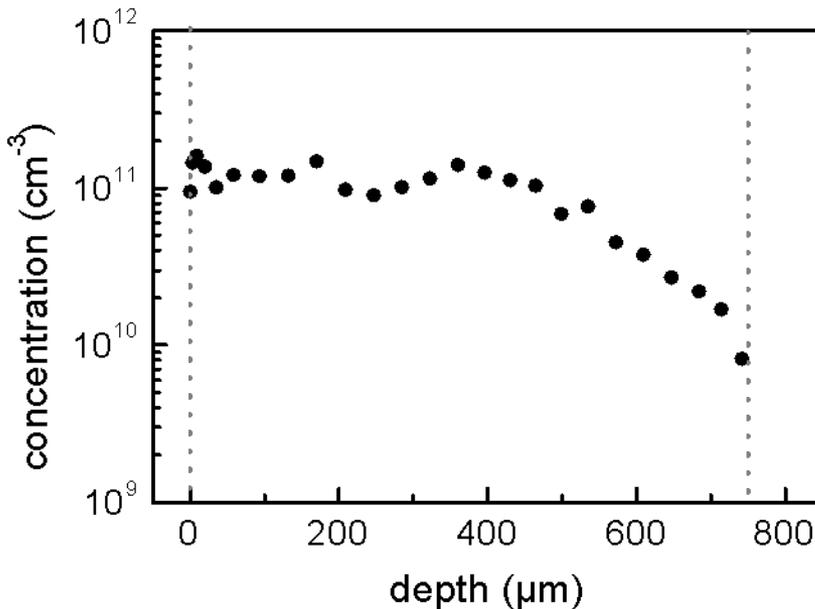
Au diffusion in CdZnTe



Au diffusion in CdZnTe



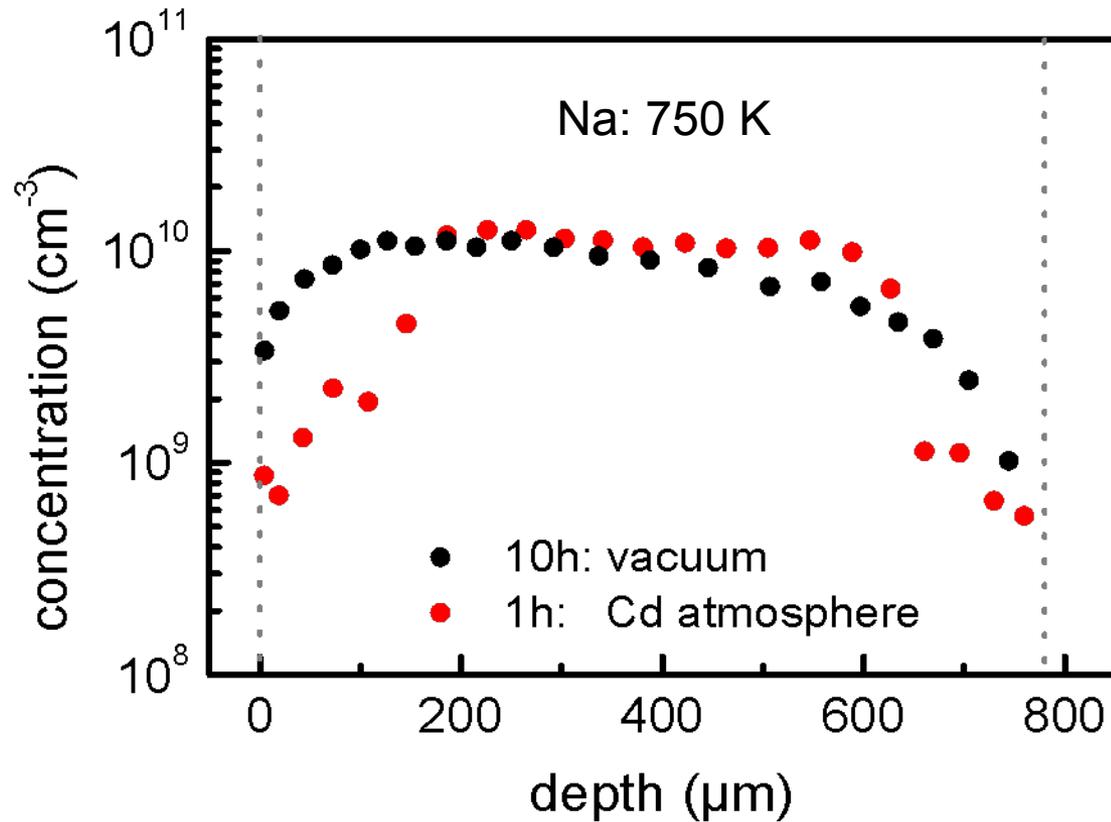
CdZnTe: 828K, 60 min, Cd atmosphere



- Up hill diffusion can be observed for Au
- $[\Delta C_{ini}] < 0$ ($V_{Cd^{2-}}$)

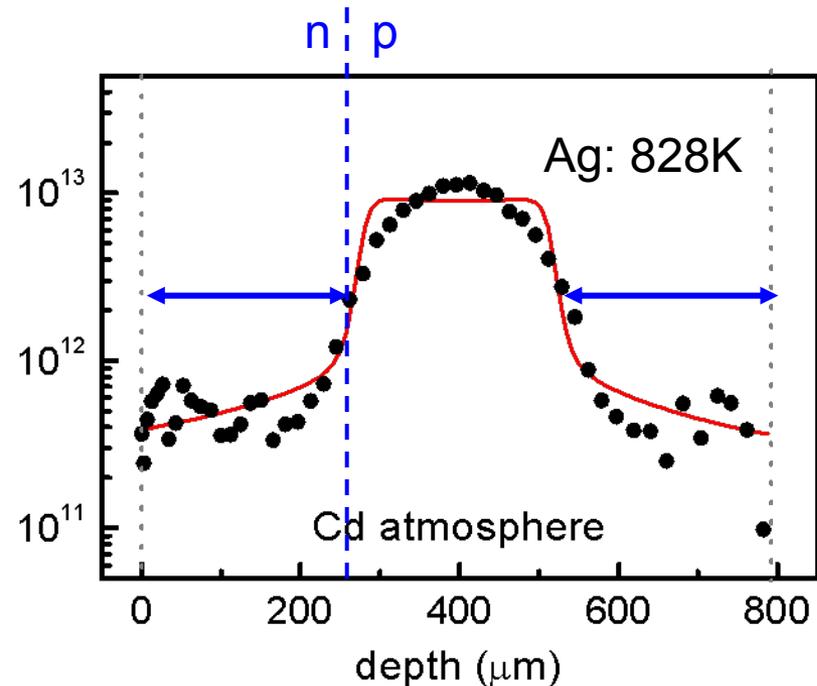
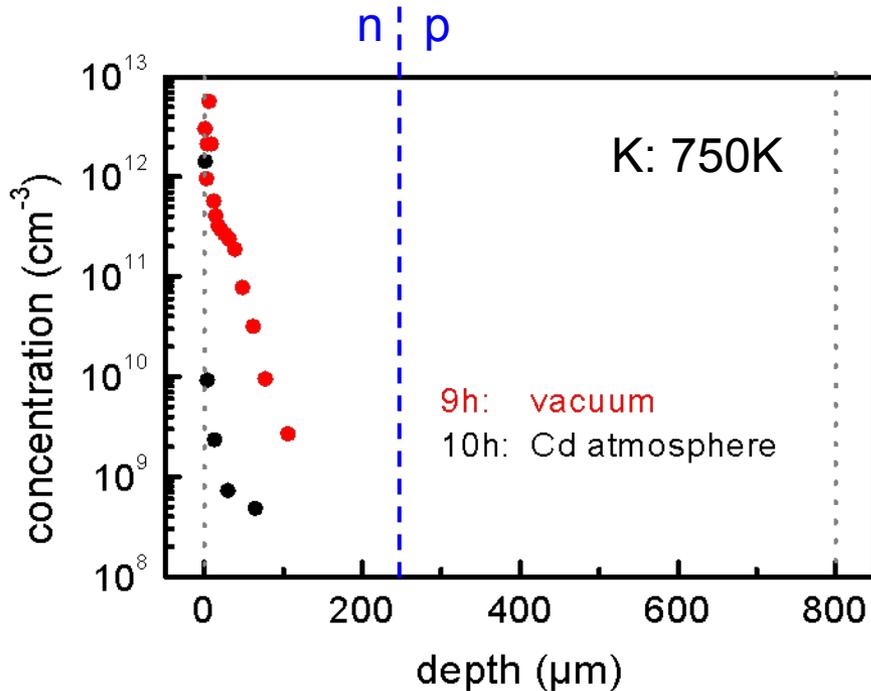
Ia																	VIII						
1 H	IIa																IIIa	IVa	Va	VIa	VIIa	2 He	
3 Li	4 Be																	5 B	6 C	7 N	8 O	9 F	10 Ne
11 Na	12 Mg	IIIb	IVb	Vb	VIb	VIIb	VIII					Ib	IIb	13 Al	14 Si	15 P	16 S	17 Cl	18 Ar				
19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr						
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe						
55 Cs	56 Ba	57 La	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi									
		57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu							

Na diffusion in CdTe



Na diffusion show up hill diffusion

K diffusion in CdTe

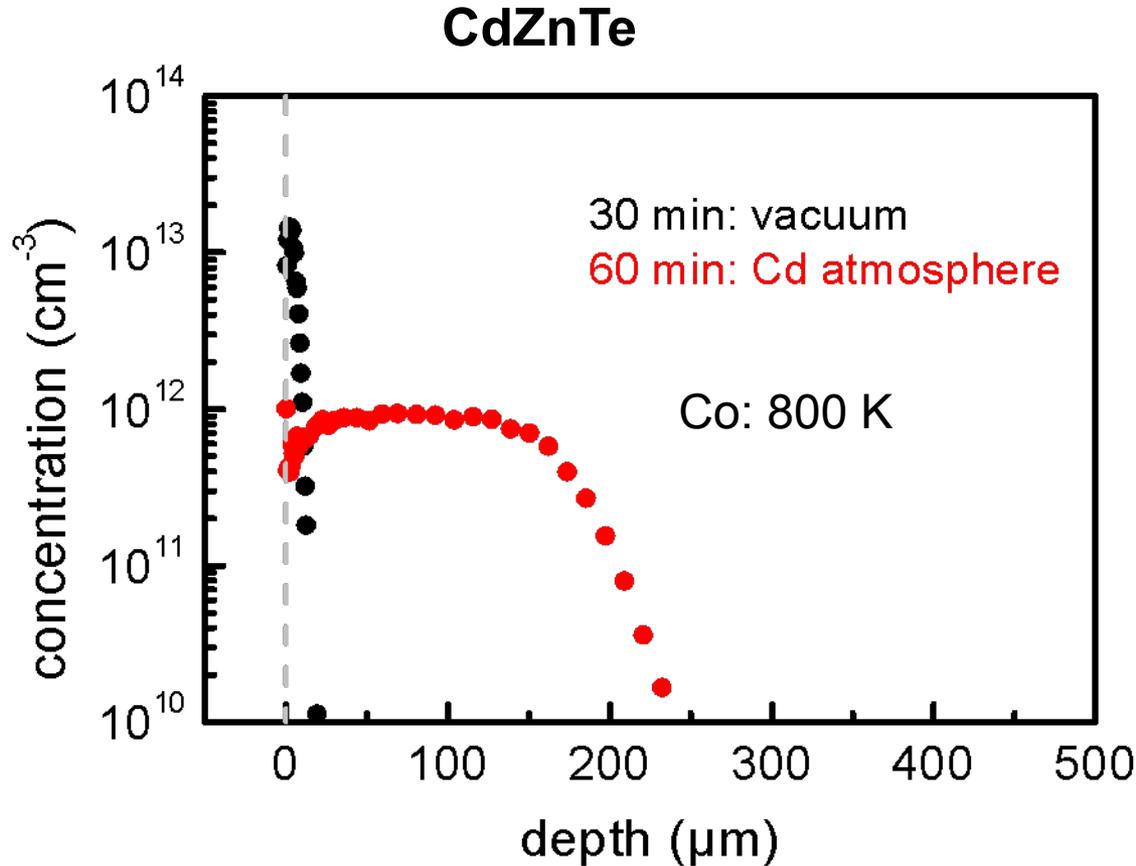


Weak penetration of K

- **diffusion in n-type part**
- **no peak-shaped profile**

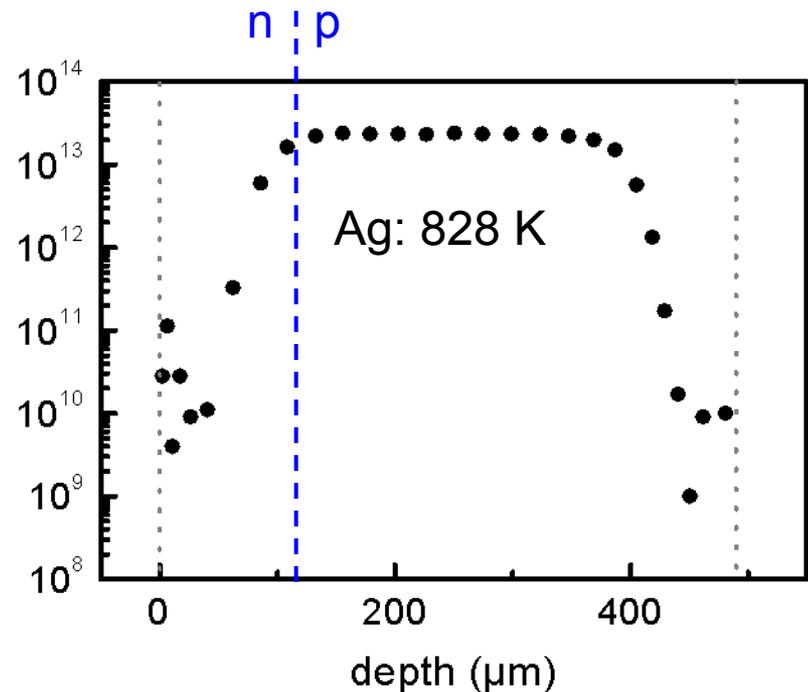
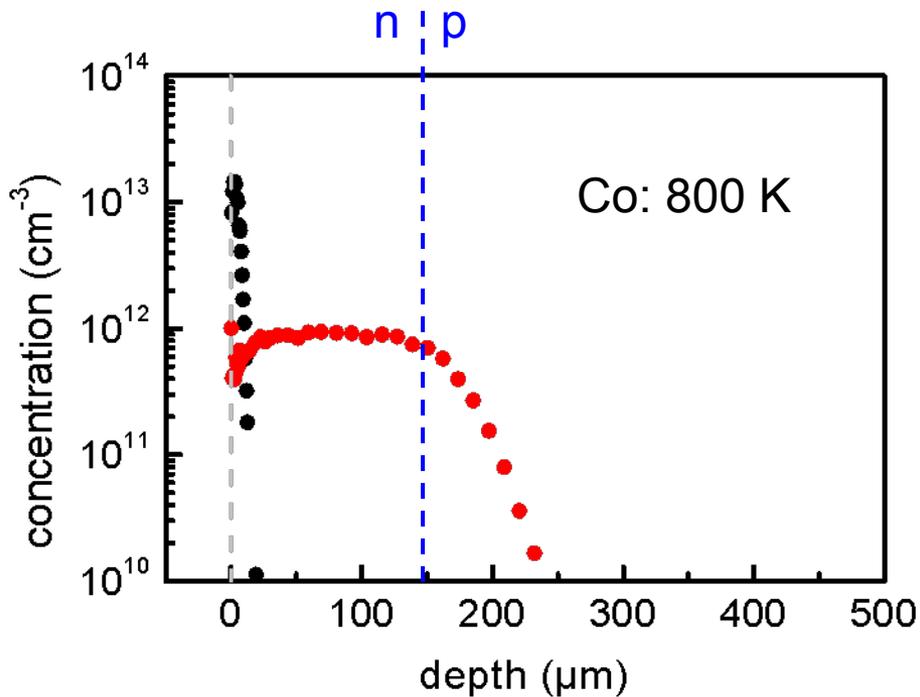
																		VIII																	
Ia																																			
H 1																						He 2													
IIa																		IIIa	IVa	Va	VIa	VIIa													
Li 3	Be 4																	B 5	C 6	N 7	O 8	F 9	Ne 10												
IIIb		IVb		Vb		VIb		VIIb		VIII			Ib	IIb	Al 13	Si 14	P 15	S 16	Cl 17	Ar 18															
Na 11	Mg 12																	K 19	Ca 20	Sc 21	Ti 22	V 23	Cr 24	Mn 25	Fe 26	Co 27	Ni 28	Cu 29	Zn 30	Ga 31	Ge 32	As 33	Se 34	Br 35	Kr 36
Rb 37	Sr 38	Y 39	Zr 40	Nb 41	Mo 42	Tc 43	Ru 44	Rh 45	Pd 46	Ag 47	Cd 48	In 49	Sn 50	Sb 51	Te 52	I 53	Xe 54																		
Cs 55	Ba 56	La 57	Hf 72	Ta 73	W 74	Re 75	Os 76	Ir 77	Pt 78	Au 79	Hg 80	Tl 81	Pb 82	Bi 83																					
																		La 57	Ce 58	Pr 59	Nd 60	Pm 61	Sm 62	Eu 63	Gd 64	Tb 65	Dy 66	Ho 67	Er 68	Tm 69	Yb 70	Lu 71			

Co diffusion in CdZnTe



- Co diffusion enhanced by Cd atmosphere
- Box shaped Co profile

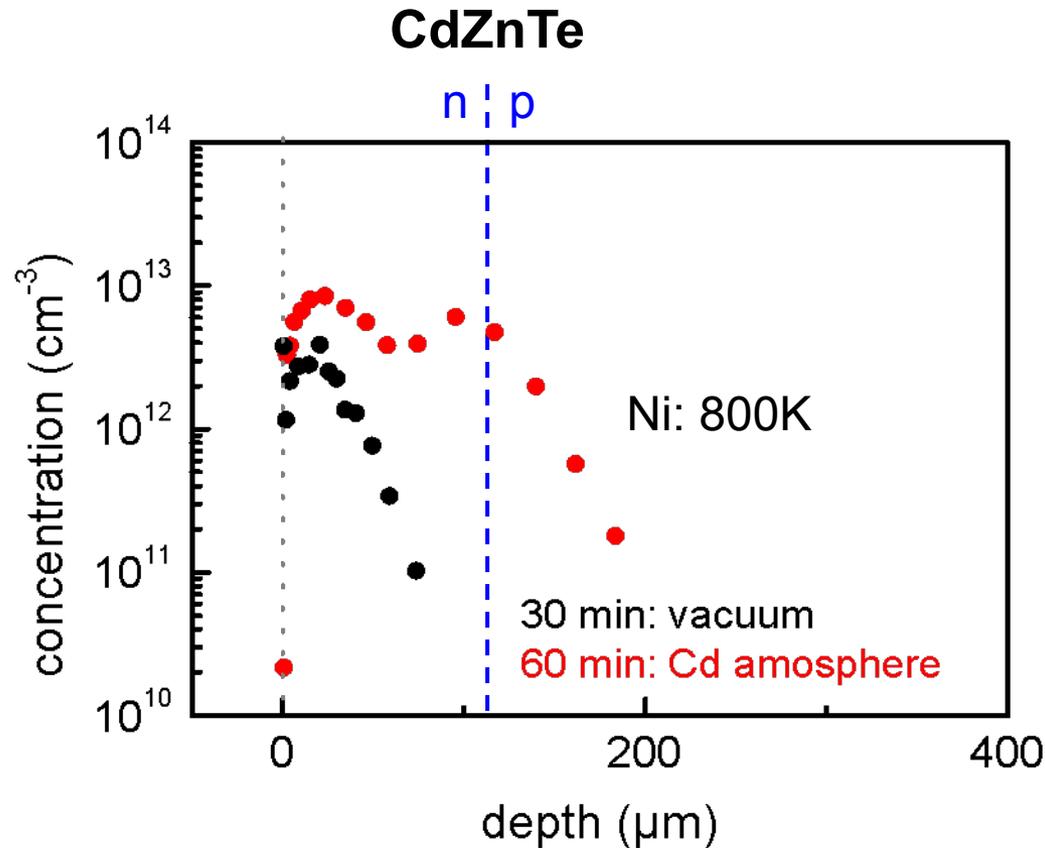
Co diffusion in CdZnTe



Te rich (p-type): low mobility
Cd rich (n-type): high mobility

- incorporation as Co_{Cd} ?
- Co present as Co_i
- Co_i negatively charged ?

Ni diffusion in CdZnTe



Ni diffusion behaves similar to Co diffusion

Summary



- Up hill diffusion for different elements
- Up hill diffusion in different semiconductors

Ia												VIII					
H 1	IIa										IIIa	IVa	Va	VIIa	VIIa	He 2	
Li 3	Be 4											B 5	C 6	N 7	O 8	F 9	Ne 10
Na 11	Mg 12	IIIb	IVb	Vb	VIb	VIIb	VIII			Ib	IIb	Al 13	Si 14	P 15	S 16	Cl 17	Ar 18
K 19	Ca 20	Sc 21	Ti 22	V 23	Cr 24	Mn 25	Fe 26	Co 27	Ni 28	Cu 29	Zn 30	Ga 31	Ge 32	As 33	Se 34	Br 35	Kr 36
Rb 37	Sr 38	Y 39	Zr 40	Nb 41	Mo 42	Tc 43	Ru 44	Rh 45	Pd 46	Ag 47	Cd 48	In 49	Sn 50	Sb 51	Te 52	I 53	Xe 54
Cs 55	Ba 56	La 57	Hf 72	Ta 73	W 74	Re 75	Os 76	Ir 77	Pt 78	Au 79	Hg 80	Tl 81	Pb 82	Bi 83			
La 57	Ce 58	Pr 59	Nd 60	Pm 61	Sm 62	Eu 63	Gd 64	Tb 65	Dy 66	Ho 67	Er 68	Tm 69	Yb 70	Lu 71			