Mystical source of electrically active chlorine at Cl doped CdTe

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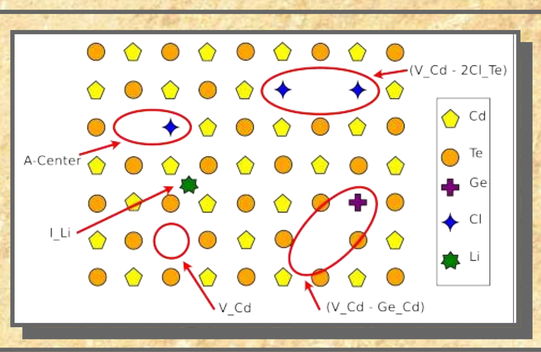
1. Highlights

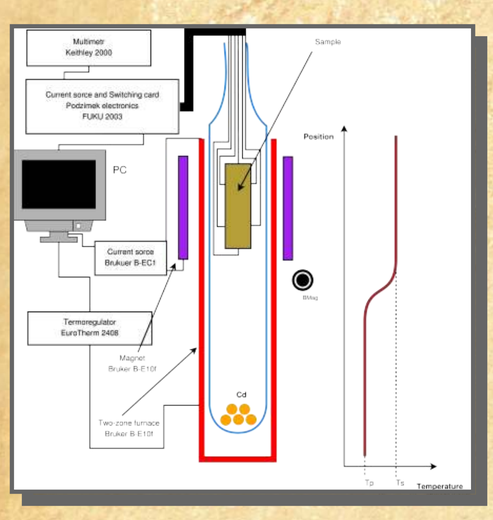
- *Properties of Cd vacancy (V_{Cd}) represent a big puzzle in the CdTe research. Despite big effords in investigating its basic properties (e.g. formation and ionisation energies) in the last 50 years, it still remains undisclosed.*
- *In this presentation we study properties of V_{Cd} in CdTe doped by Cl (CdTe:Cl).*
- *The linear shape of the concentration curves can be explained by activation of electrically neutral chlorine at high temperatures.*
- *Direct experimental confirmation of the effect of annealing to the vacancy in CdTe.*
- *All visible vacancies are coupled with donors-like defects (V_{Cd}-X_D) or (V_{Cd}-$2X_D$).*

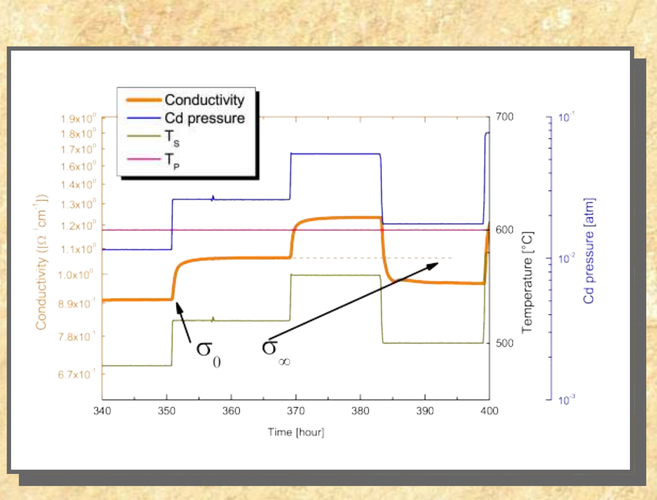
2. Point defects

- *Vacancies*
- *Intersticials*
- *A-centers (V_{Cd}-X_D)*
- *Neutral (V_{Cd}-$2X_D$)*



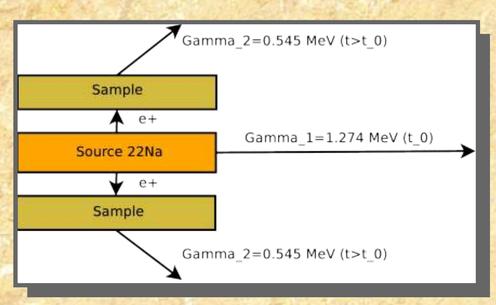
3. High temparature Hall effect

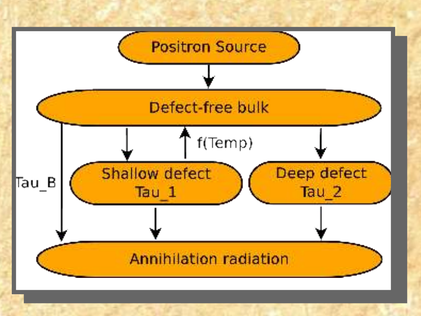




4. Positron - Experiment and Theory

Positron annihilation spectroscopy

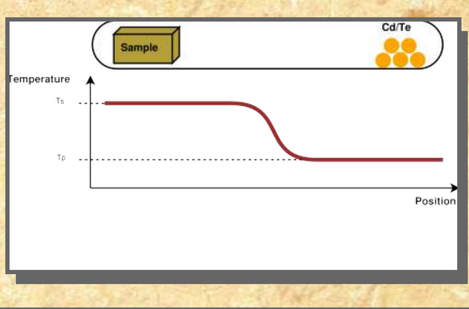




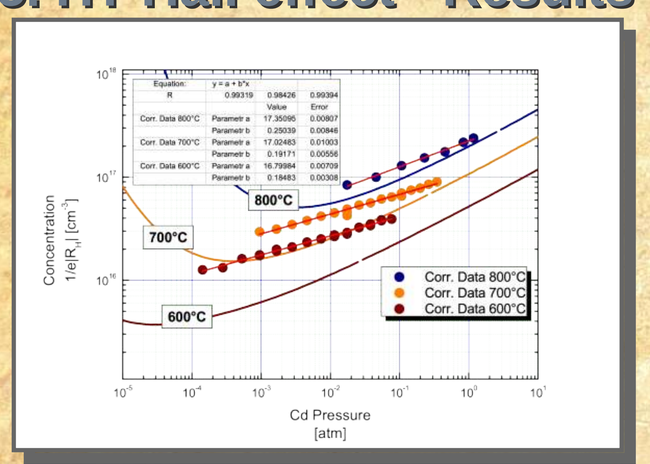
Annealing

1. *Cd overpressure (700/600)*
2. *Te overpressure (700/600)*

Chemical Analysis (GDMS)



5. HT Hall effect - Results

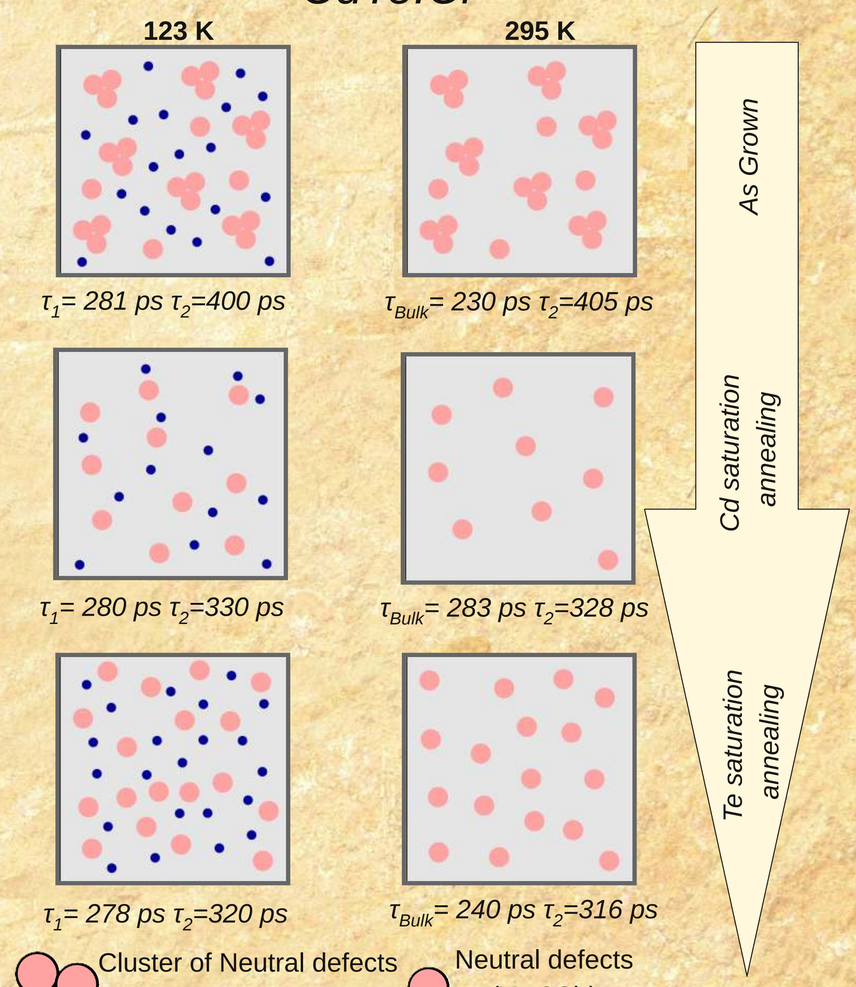


$$n \approx \left[Cd_I^{2+}\right] \approx p_{Cd}^{\frac{1}{3}}$$

- *The experimental data does not follows the standard model, the declination of experimental curves are not connected with interstitial concentration even at high pressure.*
- *This effect cannot be explained without some temperature activated defect, probably connected with chlorine.*

6. Possitron Results

CdTe:Cl



- *The CdTe:Cl contains neutral defects ($V_{Cd}2Cl_2$) grouped in clusters.*
- *The CdTe:Cl contains Rydberg states bound to chlorine A-centers visible in low temperature.*
- *Annealing CdTe:Cl at Cd pressure decreases the density neutral defects ($V_{Cd}2Cl_2$) and chlorine A-centers.*
- *Reannealing CdTe:Cl at Te pressure restorated Cd vacancies forming single A-centers.*

7. Discussion

- *CdTe:Cl contains temperature activated shallow defects, which are major defects at low temperature (123 K) - Rydberg states around chlorine A-centers.*
- *The CdTe:Cl contains also neutral defects ($V_{Cd}2Cl_2$) grouped.*
- *The concentration of defects mentioned above decreses during annealing at Cd overpressure and increases after Te annealing.*
- *Dissolution of neural defects ($V_{Cd}2Cl_2$) and chlorine A-centers is assumed to explain non standard shape of HT concentration curves.*

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References

1. *KRAUSE-REHBERG, R., et al.: Review of defect investigations by means of positron annihilation in II-VI compound semiconductors. Applied Physics A: Materials Science. 1998-6-1, vol. 66, issue 6, p. 599-614.*

Summary

- *The effect of annealing at CdTe:Cl was presented. Cd annealing leads to decrease of the density of Cd vacancies and A-centers and Te annealing restores these defects.*
- *First consistent interpretation of independent methods: positron spectroscopy, room temperature alvanomagnetic measurements, Glow Discharge Mass Spectrometry and theoretical calculation in CdTe:Cl.*
- *Simultaneous application of these methods enabled us to link directly the changes of electrical properties and development of point defects.*
- *CdTe:Cl contains temperature activated Rydberg states around chlorine A–centers, which are major defects at low temperature and this dissolution could be explanation for non standard shape of concentration curves.*