Contact and material properties of (Cd,Mn)Te and (Cd,Mn)(Te,Se)

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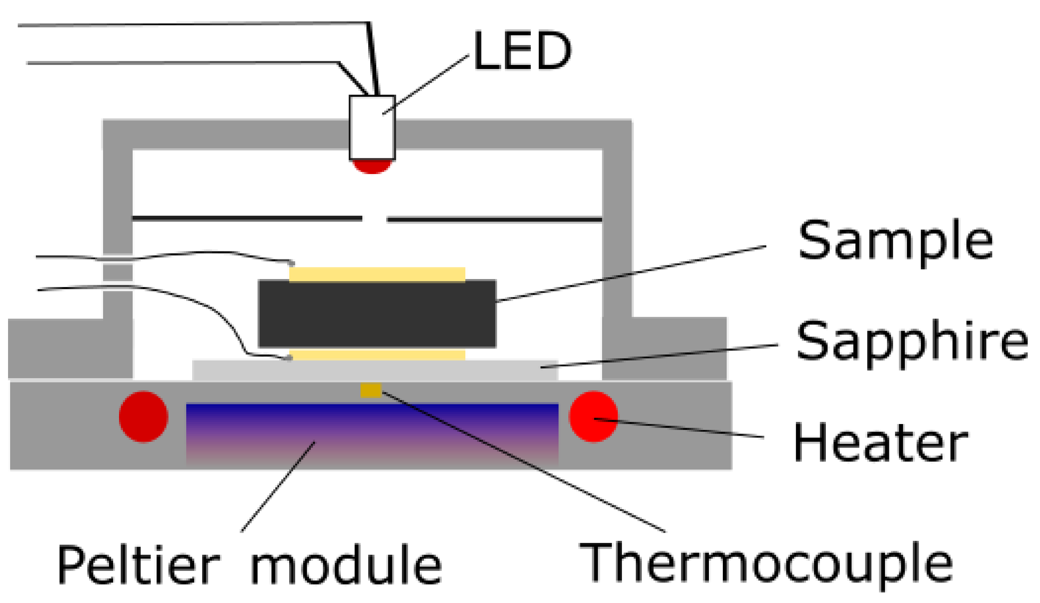
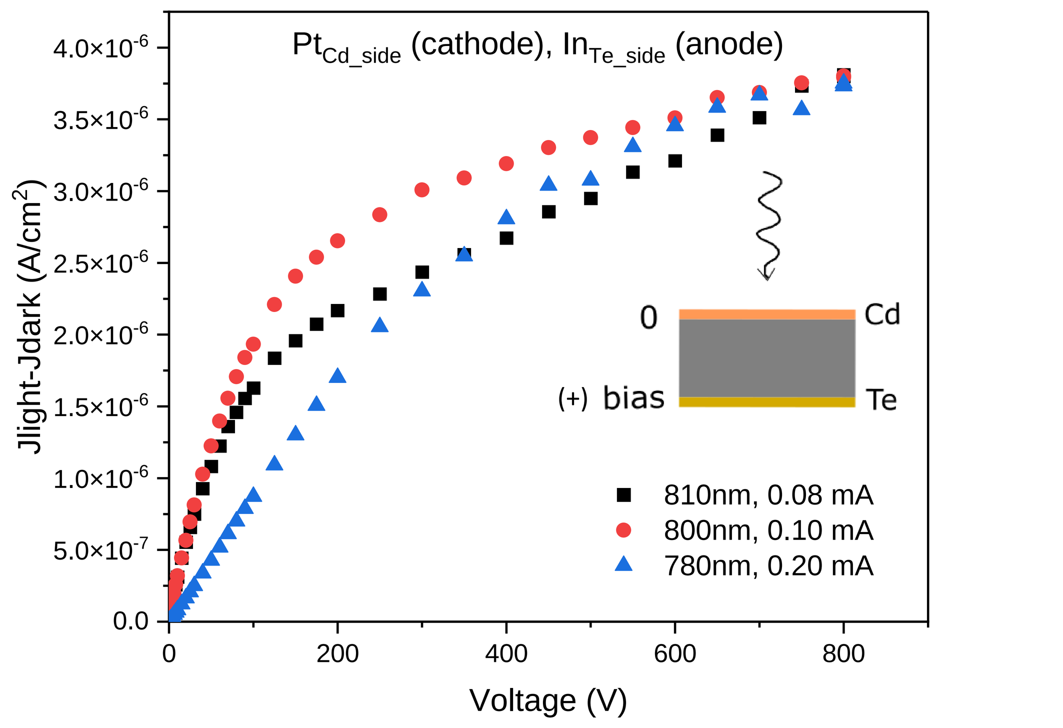
INTRODUCTION

- We investigate the transport properties of two high-resistivity (about 10^9-10^{10} Ωcm) materials – (Cd,Mn)Te and (Cd,Mn)(Te,Se) grown by the Bridgman method.
- These materials have a Zinc-blende structure. In the {111} plane, we have Cd side (A surface) and Te side (B surface). We determine the sides of the sample before contact deposition [1].
- We use the special holder to measure I-V in the temperature (IV-T) function in the range 280-345K. [2]
- We measure photocurrent as a function of applied Voltage (PC-V). We illuminate samples with light with a wavelength close to the E_g of the material. [3]
- Using the Time of Flight (TOF), we could determine the mobility of charge carriers. In this measurement we observe the trapping and de-trapping of electrons. [4, 5]



$Cd_{0.95}Mn_{0.05}Te$:In,V [In] =$1\cdot10^{17}$ cm^{-3}, V =$1\cdot10^{12}$ cm^{-3}

PC-V



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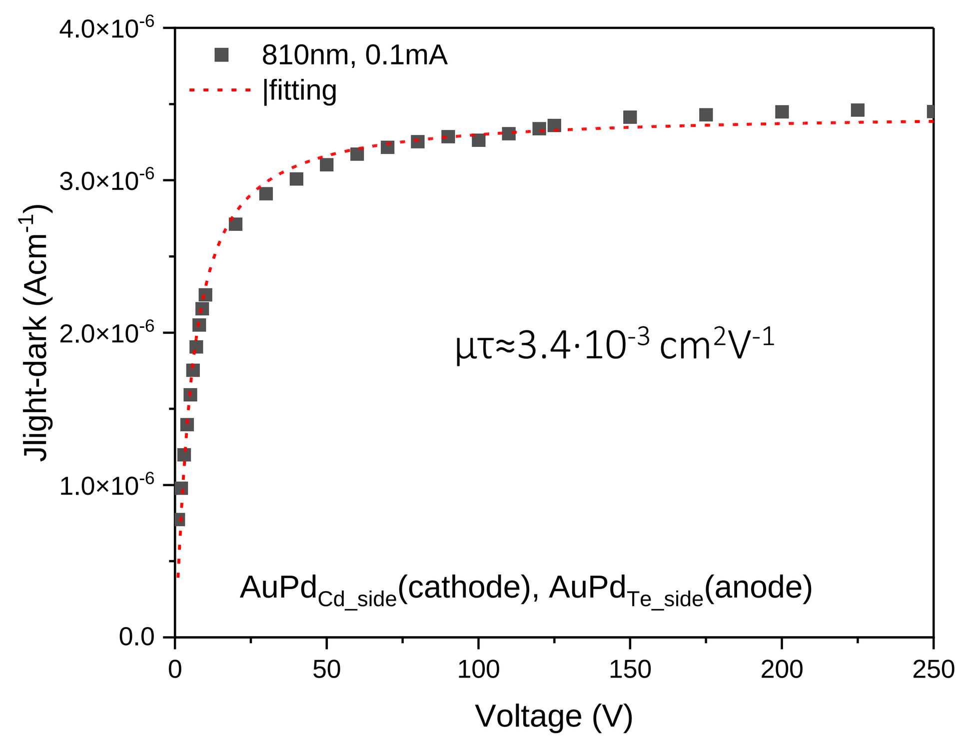
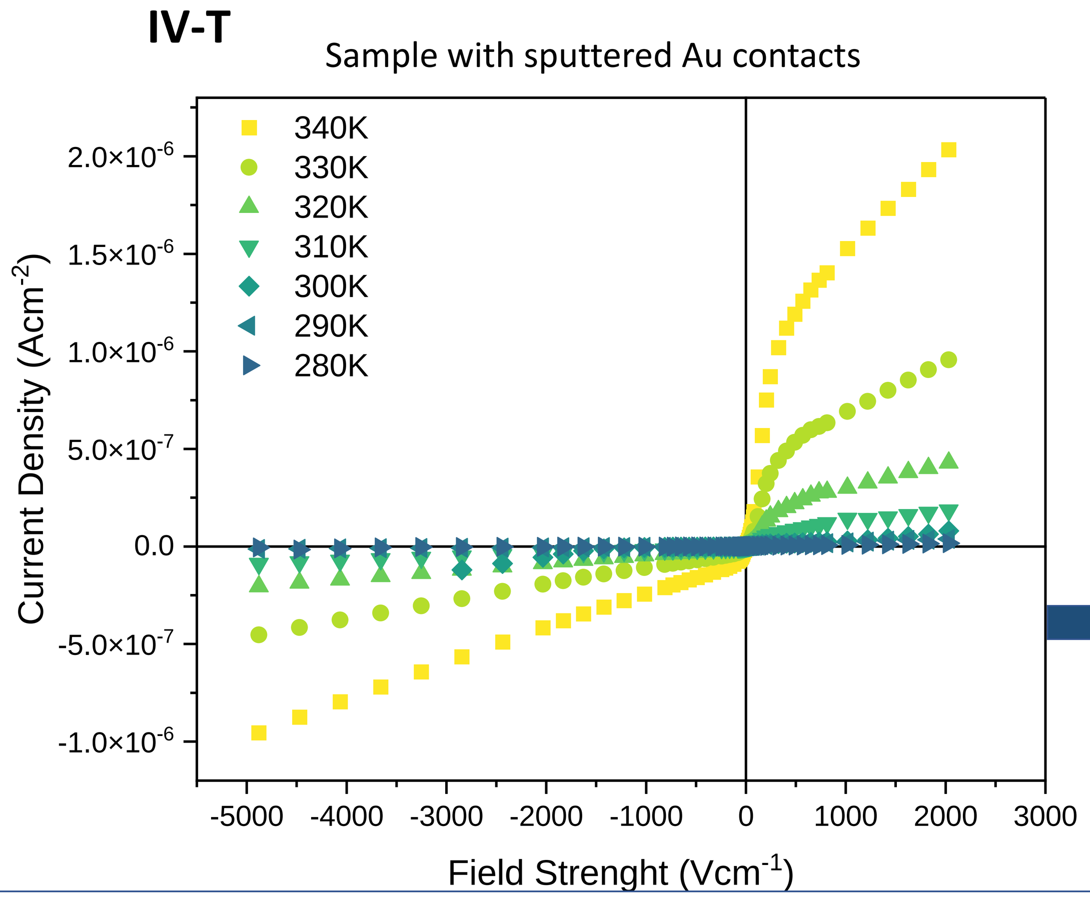
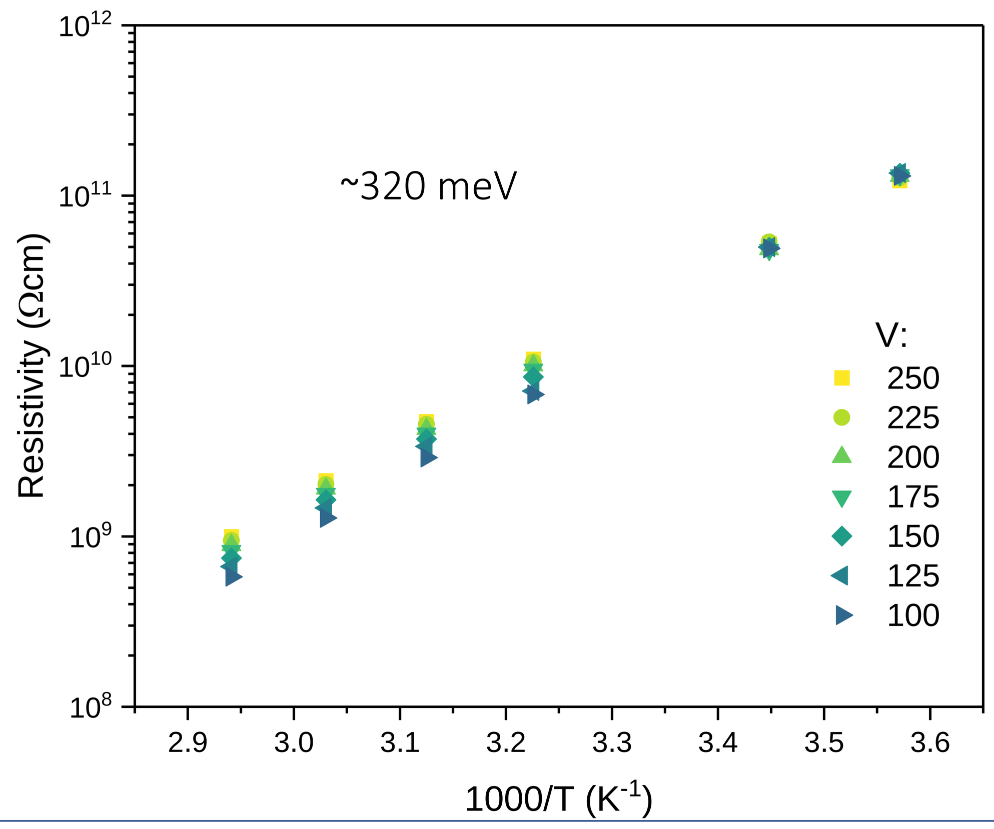
PC-V



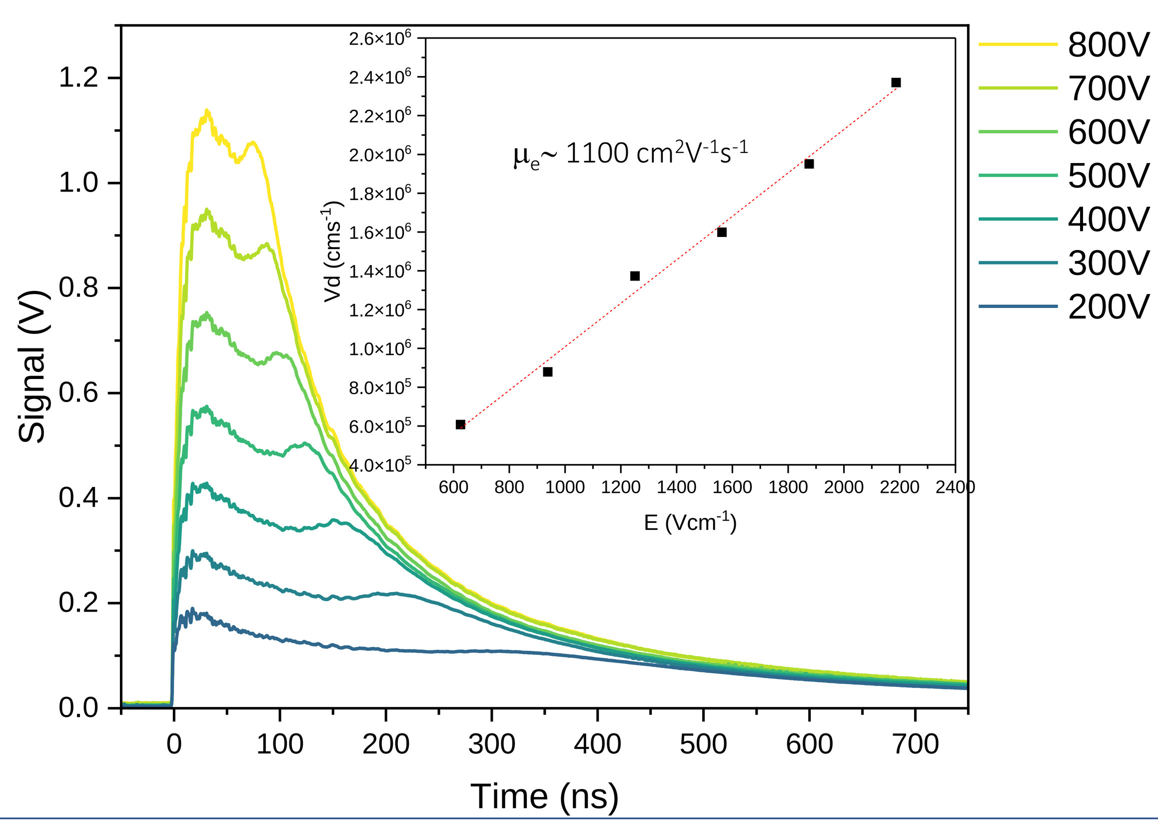
$Cd_{0.95}Mn_{0.05}Te$:In [In] =$1\cdot10^{17}$ cm^{-3}

IV-T





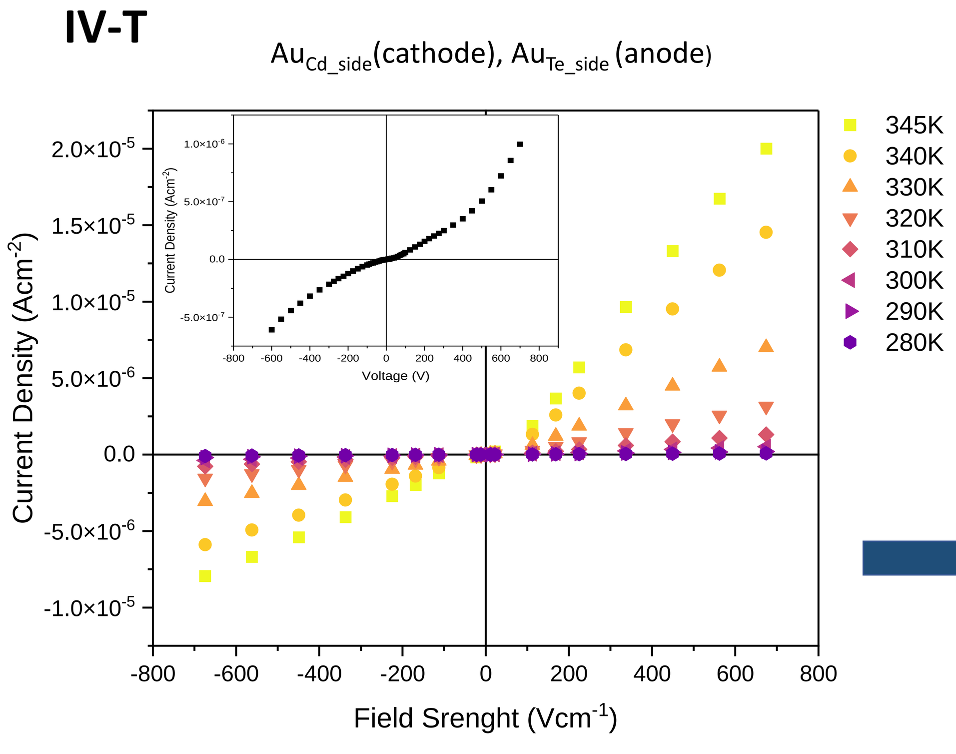
TOF

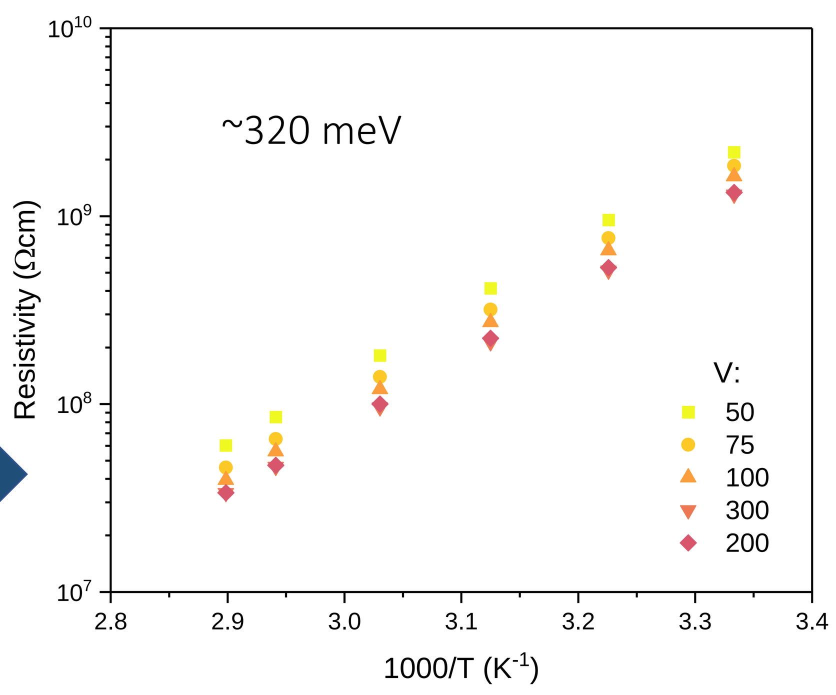


$Cd_{0.95}Mn_{0.05}Te_{0.98}Se_{0.02}$:In,V [In] =$5\cdot10^{16}$ cm^{-3}, V =$1\cdot10^{13}$ cm^{-3}

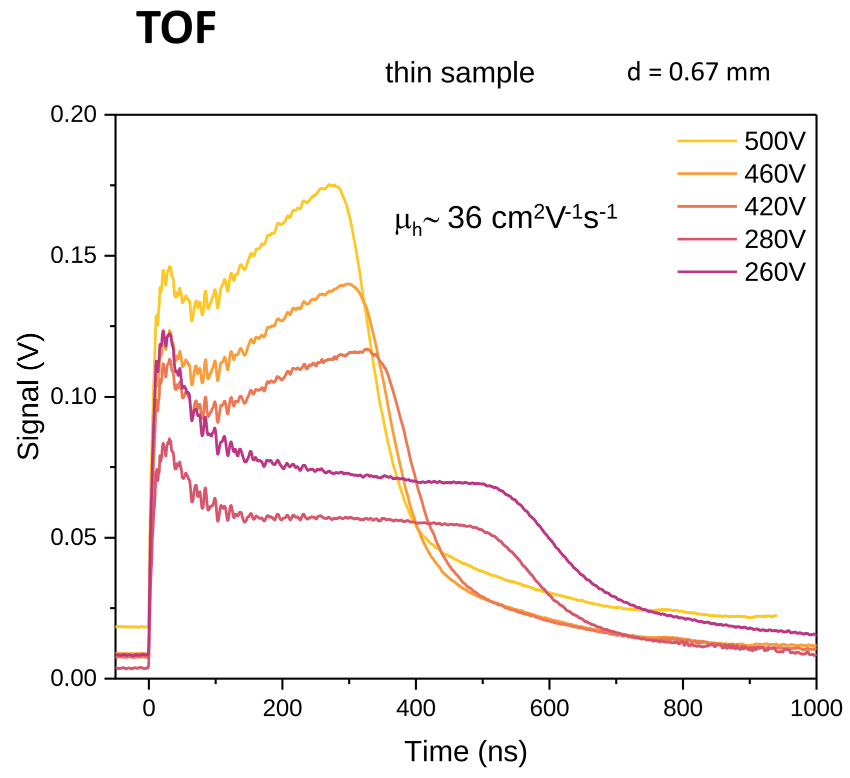
Samples with sputtered semi-transparent (10-15 nm) Au contacts

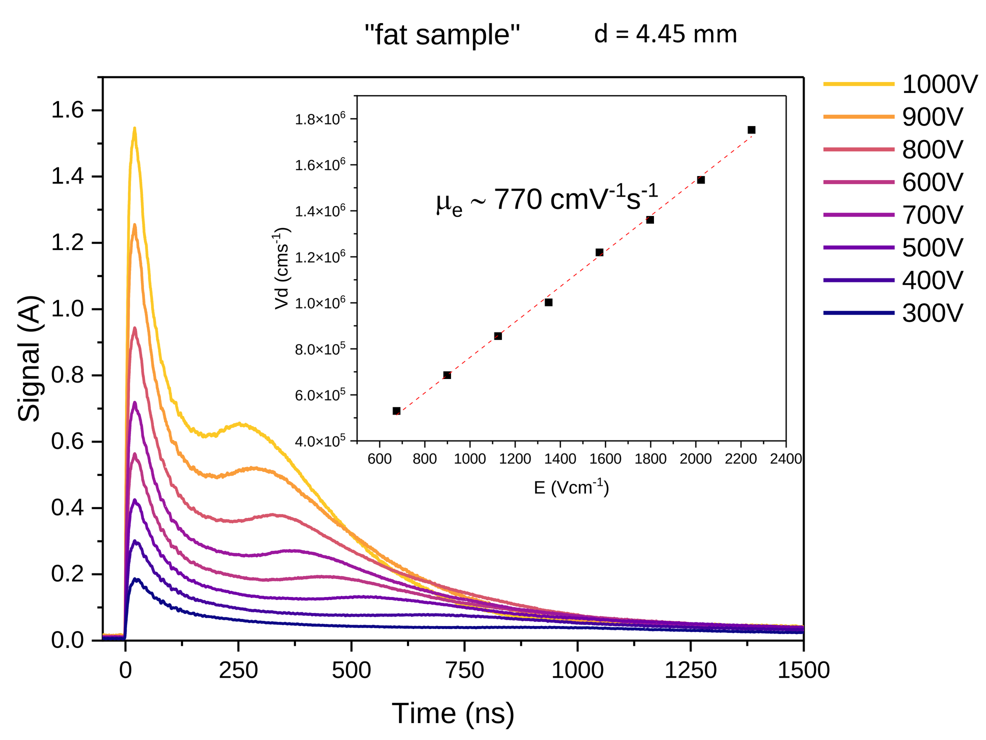
IV-T





TOF





SUMMARY

- We measure electron mobilities of charge carriers in different semi-isolating samples.
- Maesured electron and hole mobilities are smaller for (Cd,Mn)(Te,Se) material.
- In all samples, we see about 320 meV activation energy. Similar energy activation was observed by Kim in (Cd,Zn)Te [6]. In our previous work, we observed a PL spectra line with comparable energy [7]. The trapping of electrons is likely connected to this energy level.

REFERENCES

[1] J. W. P.D. Brown, K.Durose, G.J.Russel, "The absolute determination of CdTe crystal polarity," *J Cryst Growth*, vol. 101, pp. 211–215, 1990;

[2] S. J. Bell *et al.*, "Comparison of the surfaces and interfaces formed for sputter and electroless deposited gold contacts on CdZnTe," *Appl Surf Sci*, vol. 427, pp. 1257–1270, Jan. 2018;

[3] A. Mycielski *et al.*, "Surface Recombination and Space-Charge-Limited Photocurrent-Voltage (PC-V) Measurements in (Cd,Mn)Te Samples–Kinetics of Photocurrent (PC)," *Sensors*, vol. 22, no. 8, 2022;

[4] K. Suzuki et al., "Time-of-Flight Measurements on Schottky CdTe Detectors," in *IEEE Transactions on Nuclear Science*, vol. 59, no. 4, pp. 1522-1525, Aug. 2012;

[5] K. Suzuki, et al., "Effect of DC Bias Field on the Time-of-Flight Current Waveforms of CdTe and CdZnTe Detectors," in IEEE Transactions on Nuclear Science, vol. 58, no. 4, pp. 1958-1963, Aug. 2011;

[6] K. Kim et al., "Two-Step Annealing to Remove Te Secondary-Phase Defects in CdZnTe While Preserving the High Electrical Resistivity," in IEEE Transactions on Nuclear Science, vol. 65, no. 8, pp. 2333-2337, Aug. 2018;

[7] A. Wardak, et al., "The 1.1, 0.8 and 0.55–0.60 eV deep bands in detector-grade CdMnTe studied by photoluminescence spectroscopy, Journal of Luminescence, Volume 231, 117833 , 2021.

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