Compensation of (Cd,Mn)Te to Obtain High Resistivity and Mobility-Lifetime Product

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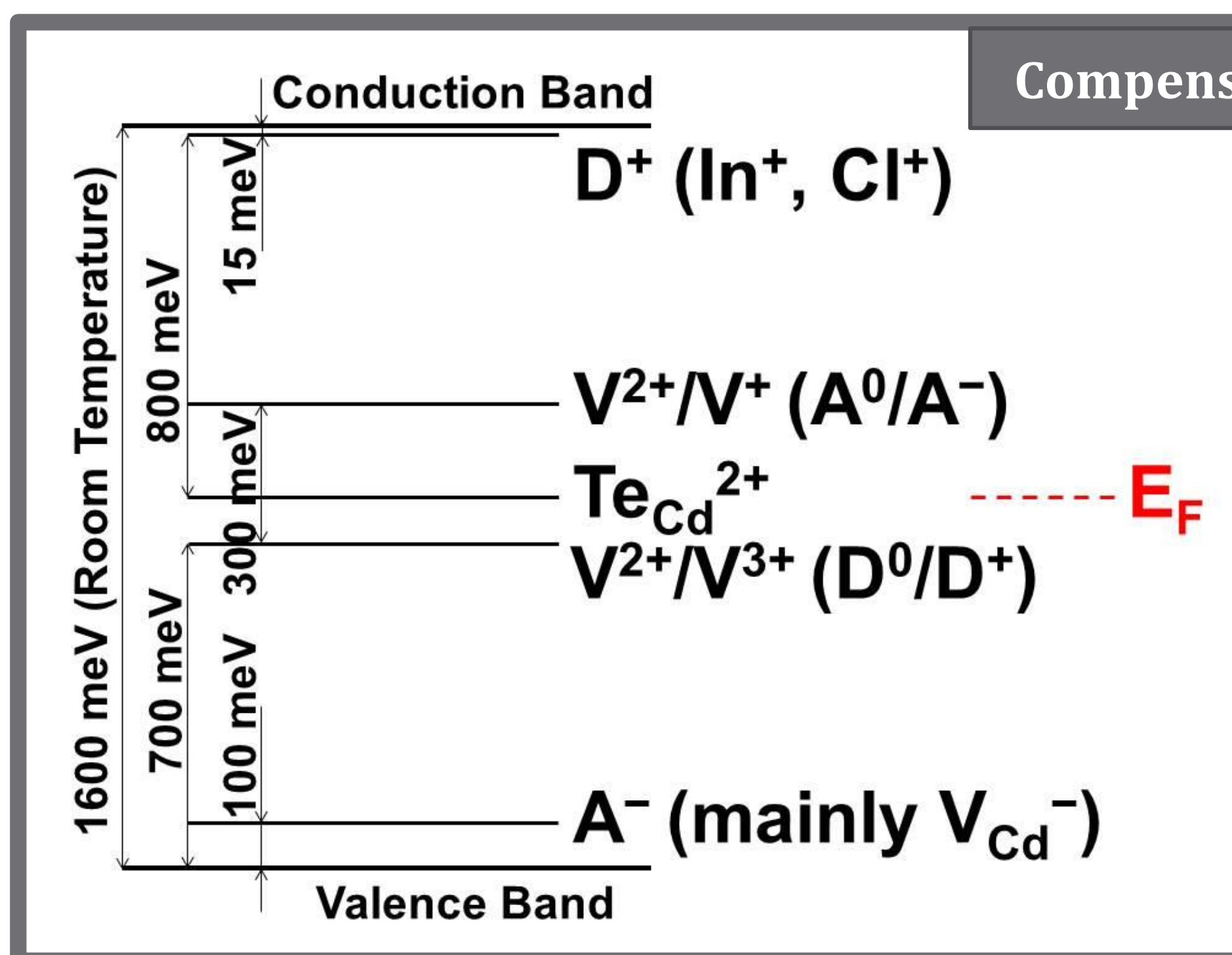
Introduction

- We grow doped $Cd_{0.95}Mn_{0.05}Te$ crystals using the low-pressure Bridgman method. The crystals are 2 or 3 inches in diameter.
- In this application, high values of **resistivity** (ρ) and **mobility-lifetime product** (μτ) are of key importance.
- We investigate the influence of dopant and excess of Te on these parameters.
- The influence of post-growth annealing processes on these parameters is also studied.
- The EU-ρ-μτ-SCAN apparatus, which uses the principle of time-dependent-charge-measurement, allowed us to map the values of resistivity and mobility-lifetime product in crystal plates.

Compensation model in (Cd,Mn)Te



In order to obtain high resistivity crystals, one has **to pin the Fermi level in the midgap**.

The model was developed on the basis of Refs. [1-5].

Type of dopant

No Dopant Excess of Te (100 mg Te per 100 g of material)	Resistivity [Ω cm]	
	As-grown	Annealed
	3.0×10^8	3.5×10^8

Impact of **indium** on the values of **ρ** and **μτ**.

Indium Concentration [cm^{-3}]	Resistivity [Ω cm]		μτ product [cm^2V^{-1}]	
	As-grown	Annealed	As-grown	Annealed
5×10^{16}	2.7×10^7	3.8×10^6		
1×10^{17}	3.0×10^9	3.0×10^8	5.0×10^{-3}	9.0×10^{-3}

Impact of **vanadium** on the values of **ρ** and **μτ**.

Vanadium Concentration [cm^{-3}]	Resistivity [Ω cm]		μτ product [cm^2V^{-1}]	
	As-grown	Annealed	As-grown	Annealed
1×10^{16}	9.3×10^9	6.7×10^9 (*)	2.3×10^{-3}	2.5×10^{-3} (*)
1×10^{17}	4.0×10^9	3.5×10^9 (*)	4.0×10^{-3}	6.5×10^{-3} (*)

(*) = more uniform distribution was obtained

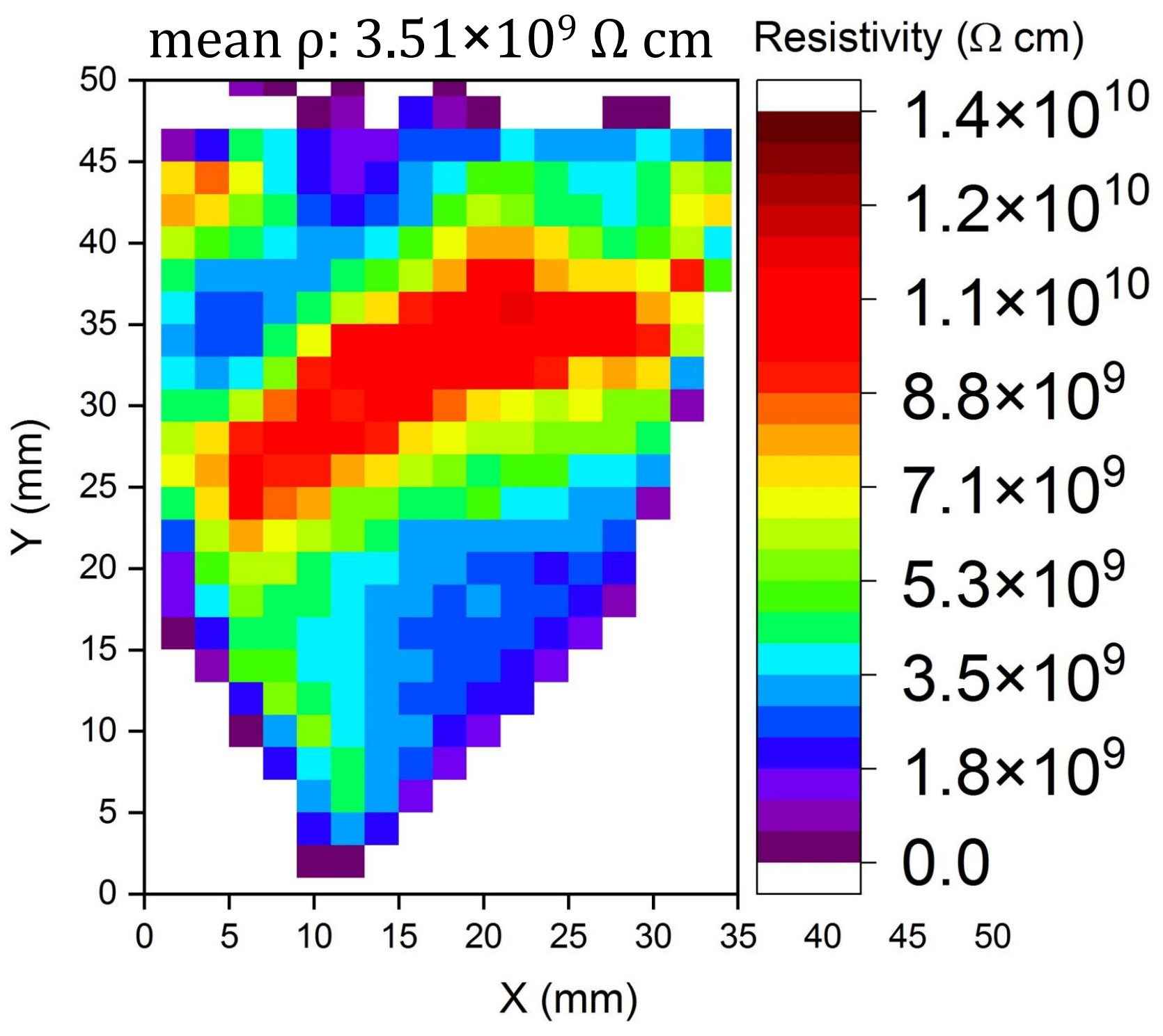
(Cd,Mn)Te: V

Resistivity map of **(Cd,Mn)Te: V**, [V]= 1×10^{17} cm^{-3}

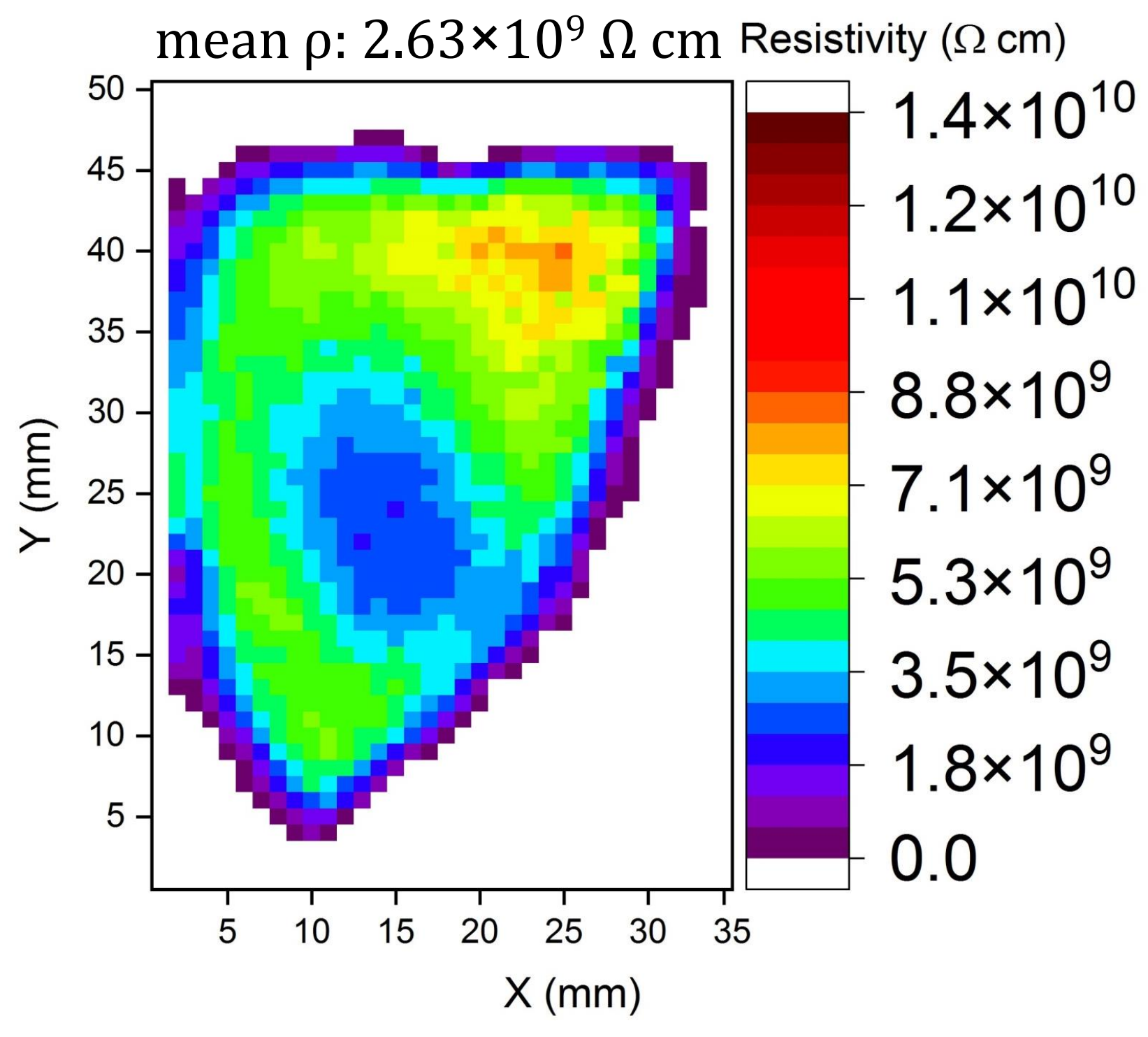
As-grown

Annealed in Cd @ 500 °C

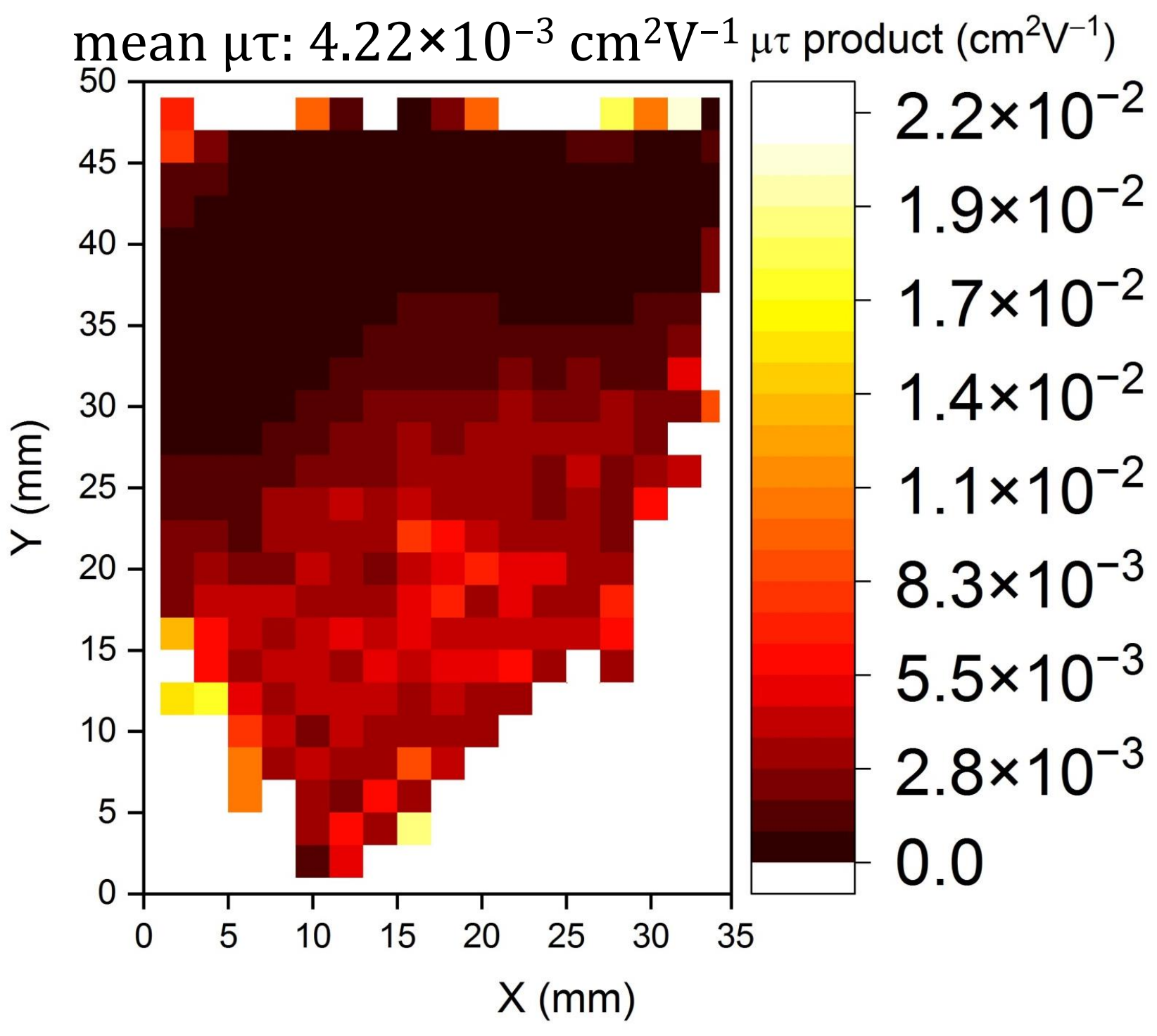
mean ρ: 3.51×10^9 Ω cm



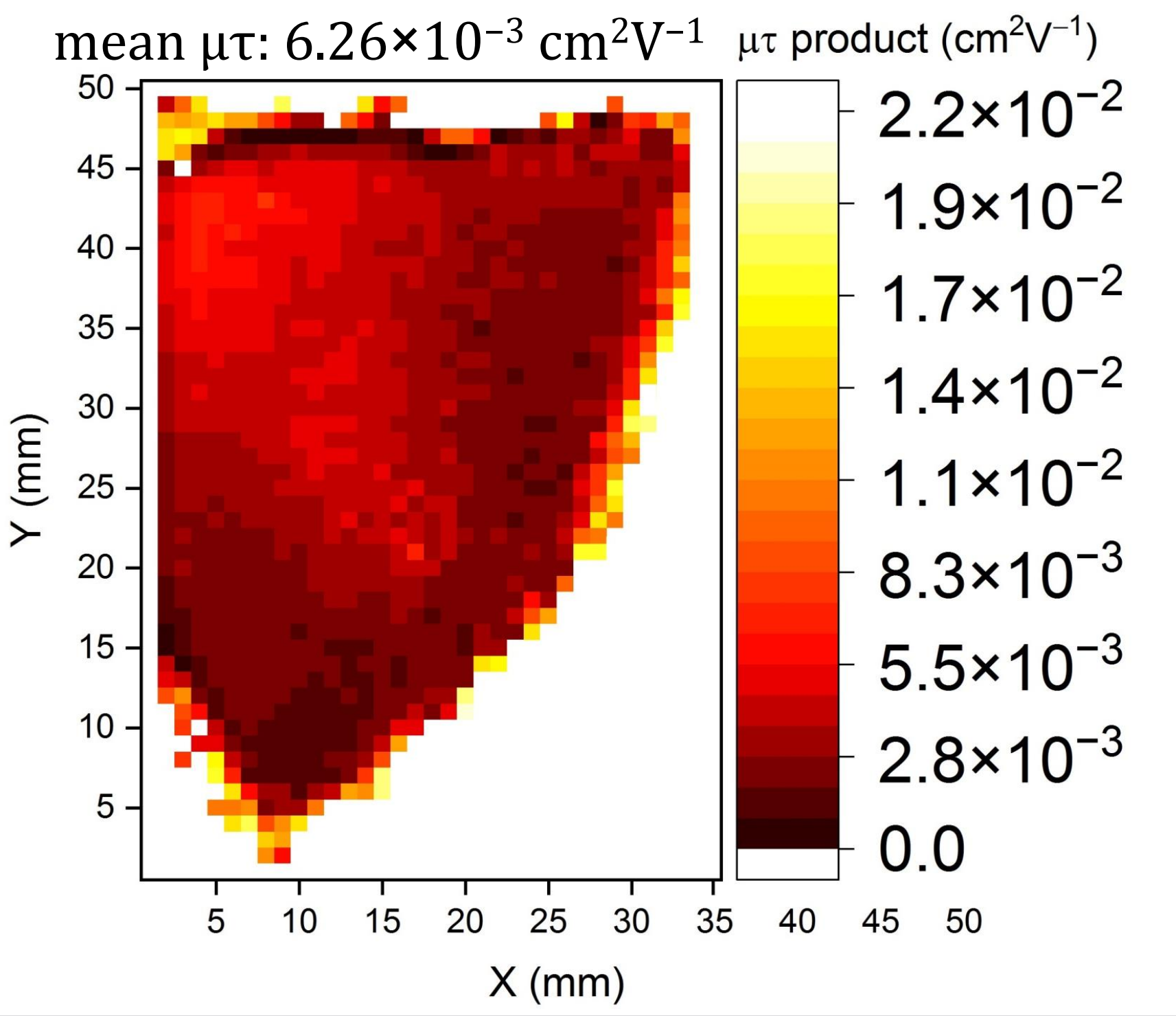
mean ρ: 2.63×10^9 Ω cm



mean μτ: 4.22×10^{-3} cm^2V^{-1}



mean μτ: 6.26×10^{-3} cm^2V^{-1}



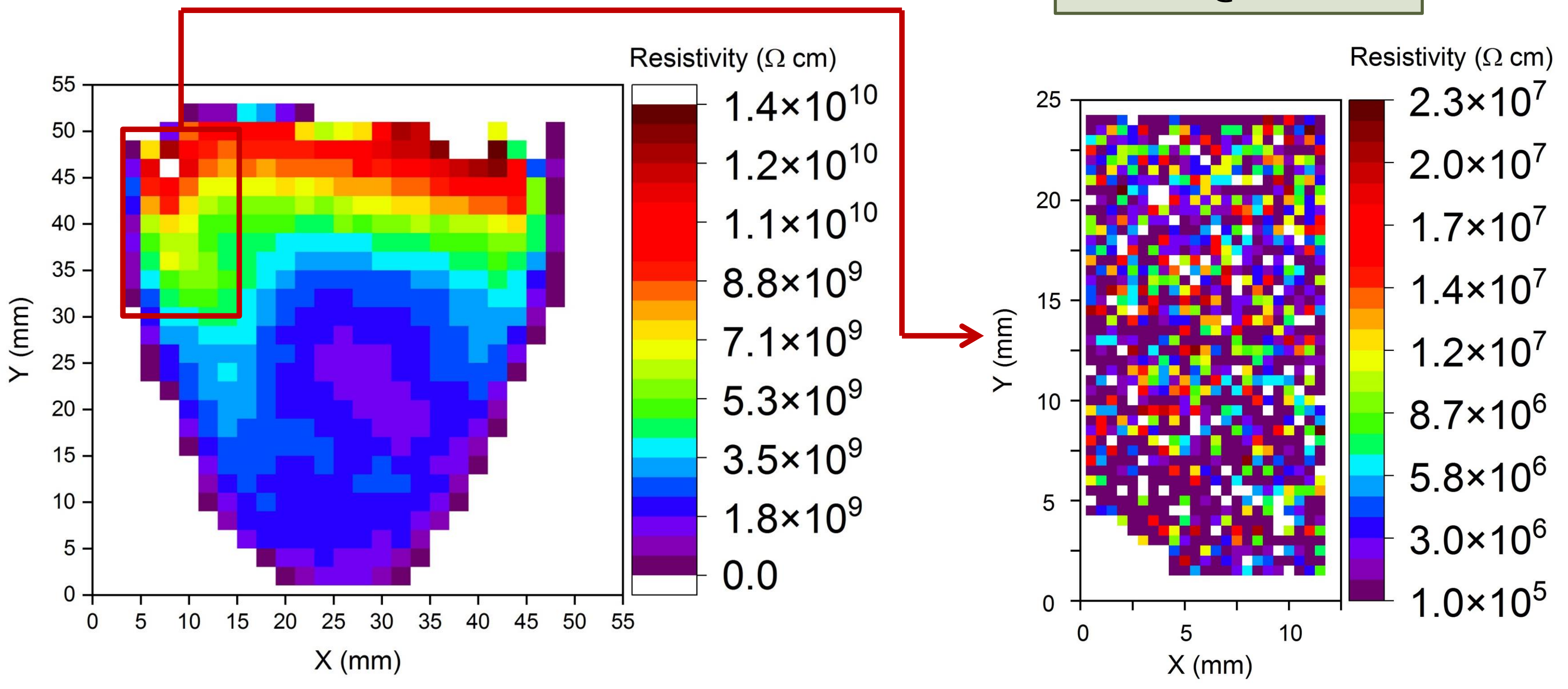
(Cd,Mn)Te: In

Resistivity map of **(Cd,Mn)Te: In**, [In]= 1×10^{17} cm^{-3}

Segregation coefficient of In in CdTe is ***k*<<1**

As-grown

Annealed in Cd @ 500 °C

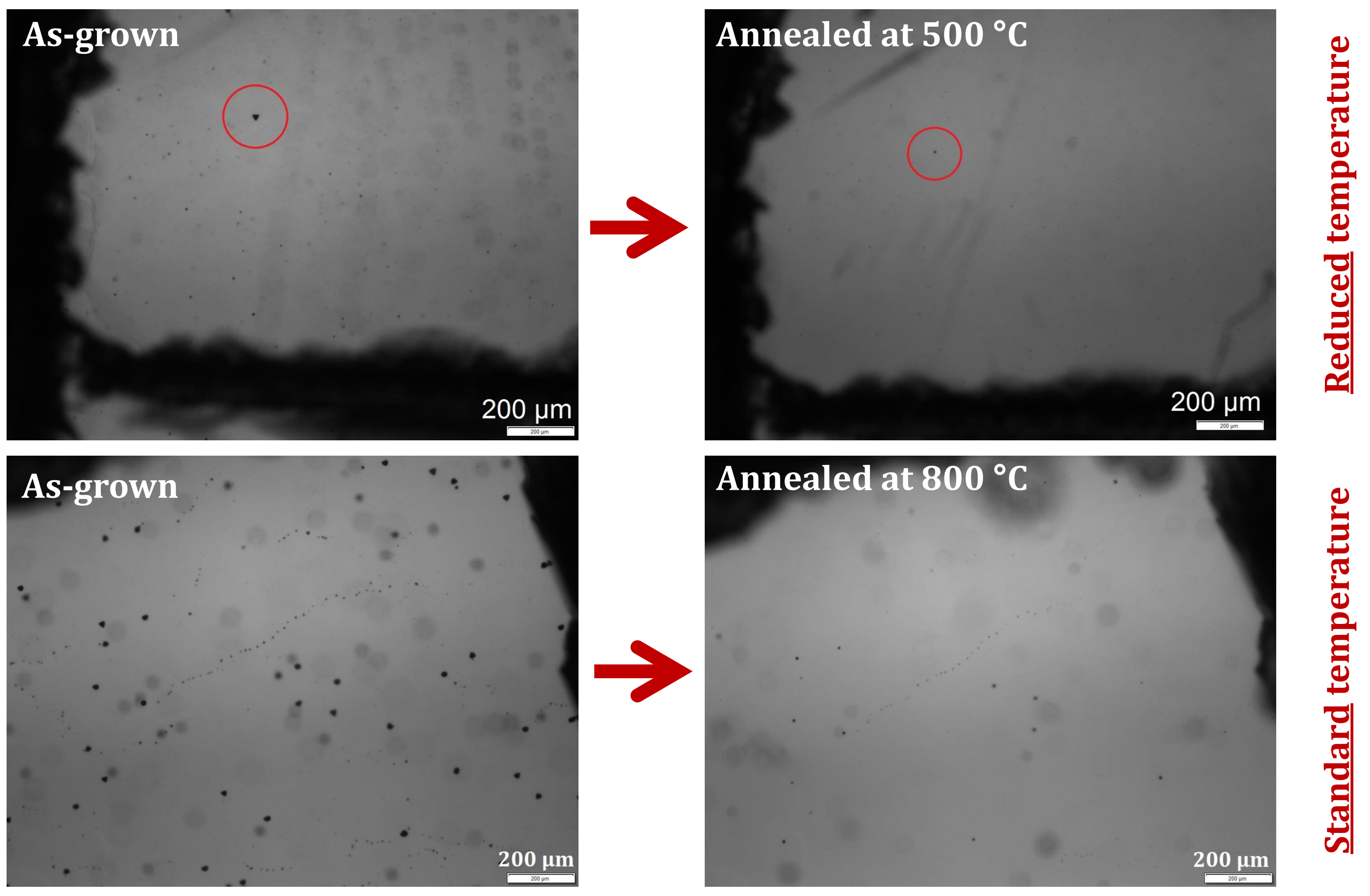


mean ρ: **2.87×10^9** Ω cm

mean ρ: **8.60×10^6** Ω cm

Infrared images

The **infrared images** confirm that both types of annealing in Cd vapors, i.e., at 500 °C and 800°C, reduce the size and concentration of Te inclusions.



Summary

- The (Cd,Mn)Te samples should be annealed in order to reduce the density of Te inclusions and obtain a uniform distribution of the values of resistivity (ρ) and mobility-lifetime product (μτ).
- The annealing process of (Cd,Mn)Te:**In** crystals is ineffective. The annealed crystal plates are overcompensated and a **reduction in the resistivity value is observed**.
- The annealing process of (Cd,Mn)Te:**V** crystals results in more uniform distribution of the ρ and μτ values.
- Low-temperature annaling (at 500 °C) reduces the number and size of Te inclusions.

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