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LGAD irradiated with 10^{19} 1MeV n/cm^2 - HRTEM annealing studies up to 350 ^{o}C

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INTRODUCTION

- A LGAD sample irradiated at a fluence of 10^{19} 1MeV neutrons/cm^2
- Around room temperature: Point defects (vacancies and interstitials) expected to be present in the Si
- At high temperatures (100C-300C): A clustering of point defects has been predicted by electric measurements

THE TASK

- Investigate the potential presence of defects (by TEM)
- Investigate a potential evolution of defects with temperature (by TEM)

THE CHALLENGES

- Prepare the sample
- Avoid or minimize electron beam induced defects.

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Instrumentation

Instrument:

- JEOL 2100 Transmission Electron Microscope
- LaB6 electron gun (brightness much lower than field-emission gun)
- High-resolution polar piece
- Low convergence of electron beam

Sample preparation:

- Standard XTEM (cross sectional) method, but heating avoided.
- Glue was dried at RT
- Gatan PIPS used for final thinning stages

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Neutrons vs electrons

For JEOL 2100 @ 800kx

$$\rho = 32 * 10^{-12} \frac{A}{cm^2} = 2 * 10^7 \frac{electrons}{cm^2 s}$$

$$for\ 100\,s\ observation\ time\ ,\ total\ dose\ D = 2 * 10^9 \frac{electrons}{cm^2}$$

! Electron dose is much lower than neutron dose. Moreover, the electrons are accelerated at only 0.2 MeV.

! The electron irradiated sample is very thin (roughly 50 nm) – NOT Bulk Sample

! It has been shown in literature that TEM may induce defects in Si.

TEM investigantions need to be performed with caution….
And they have been!

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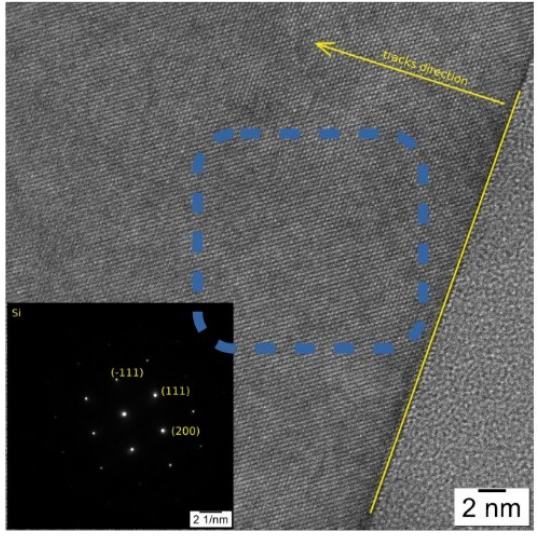
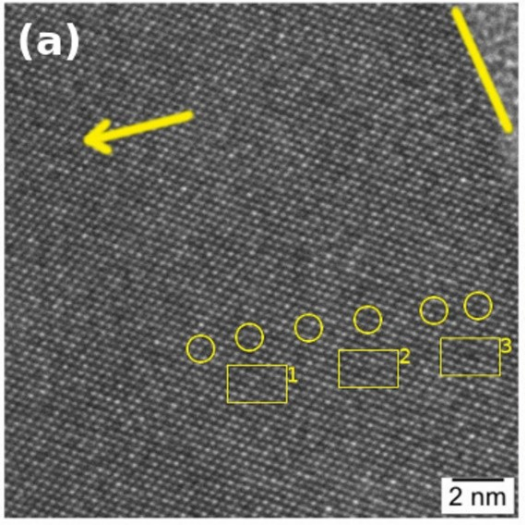
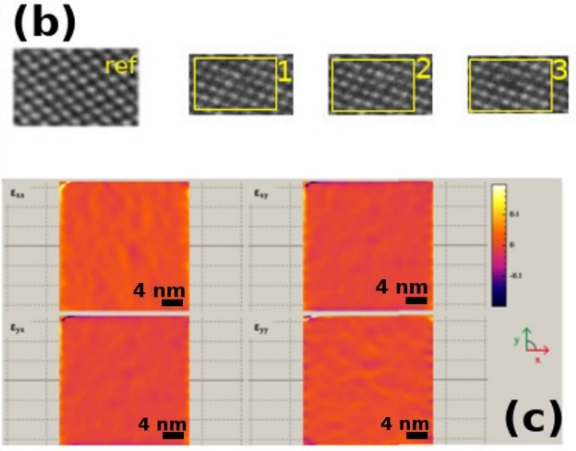
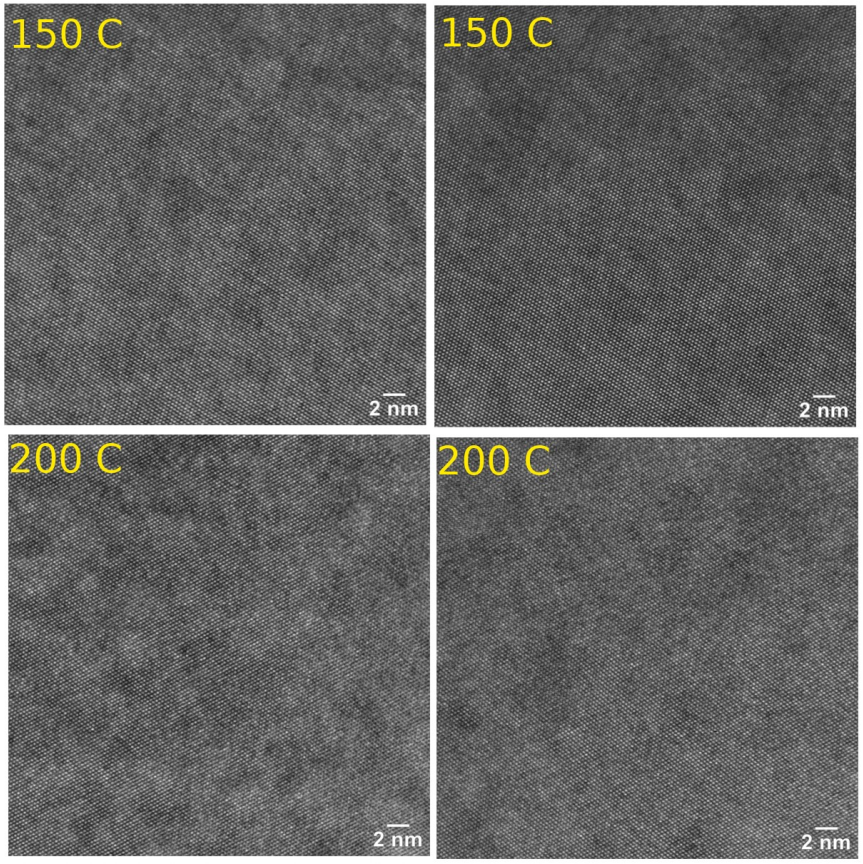
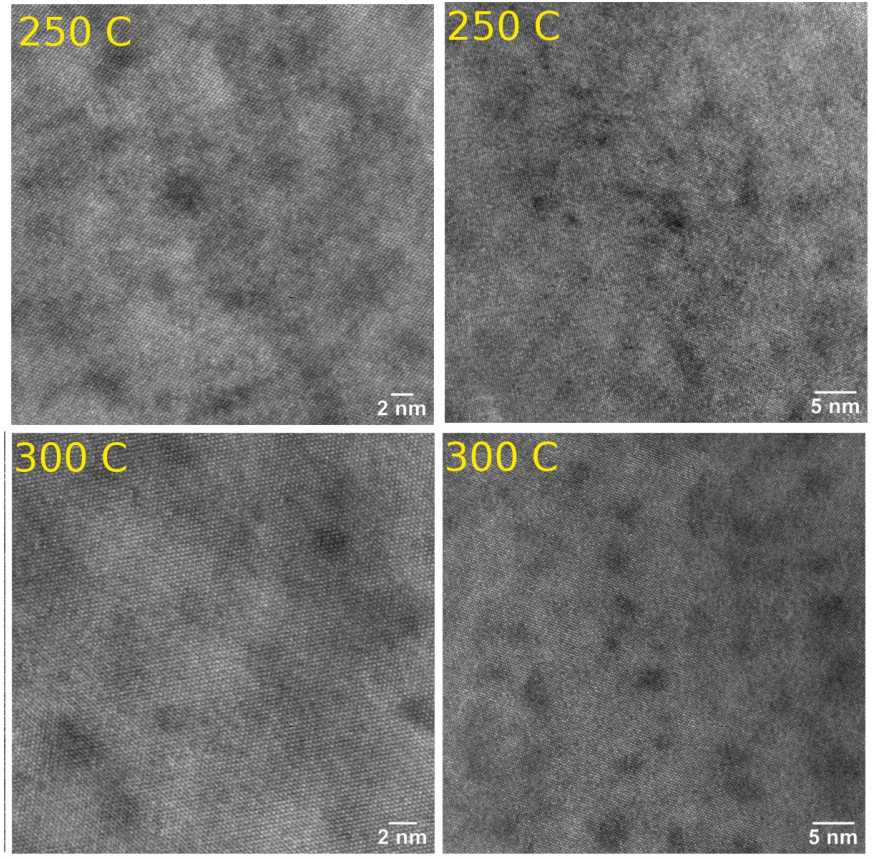
Initial state



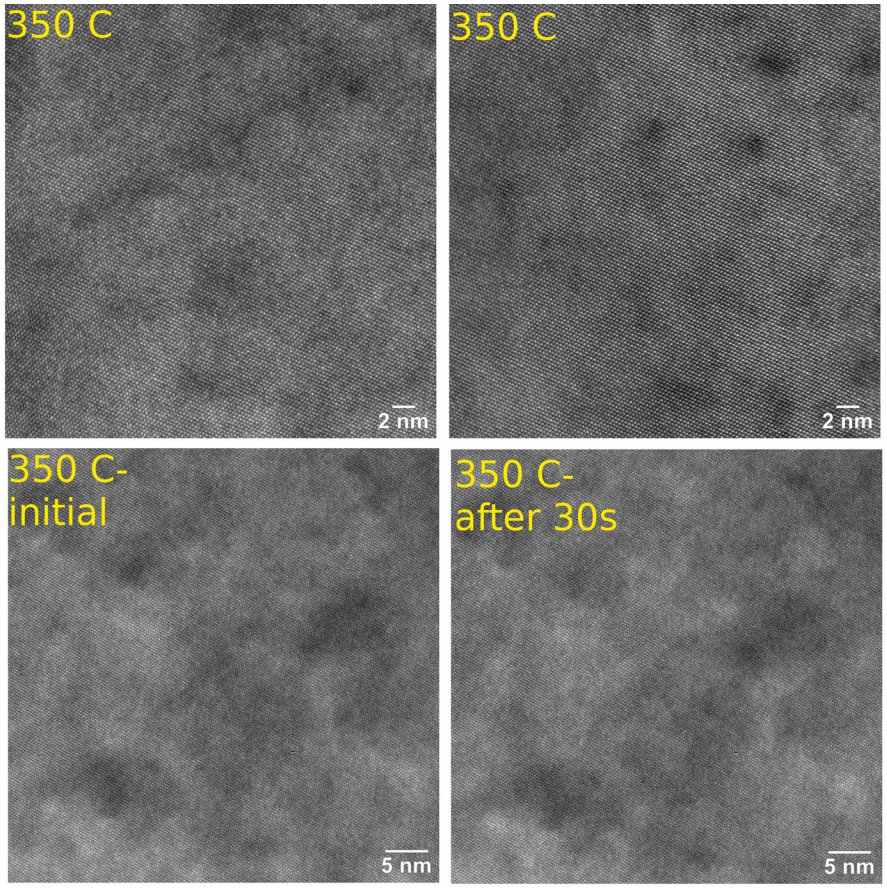








Thermal annealing- HRTEM images @800kx



Thermal annealing- HRTEM images @800kx

Observations/Conclusions

- Point defects have been observed at RT and whole thermal annealing series
- Point defects tend to organize in tracks normal to the interface
- At higher temperatures point defects tend to group in large clusters

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Perspectives

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- A TEM specimen will be will be freshly prepared
- Higher annealing temperatures (up to 450C) will be tackled

Thank You!