

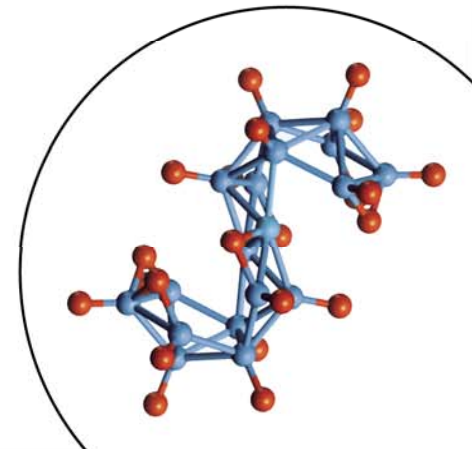


*The Cluster Implant Source*

# Extension of the Si:C stressor thickness by using multiple ClusterCarbon species

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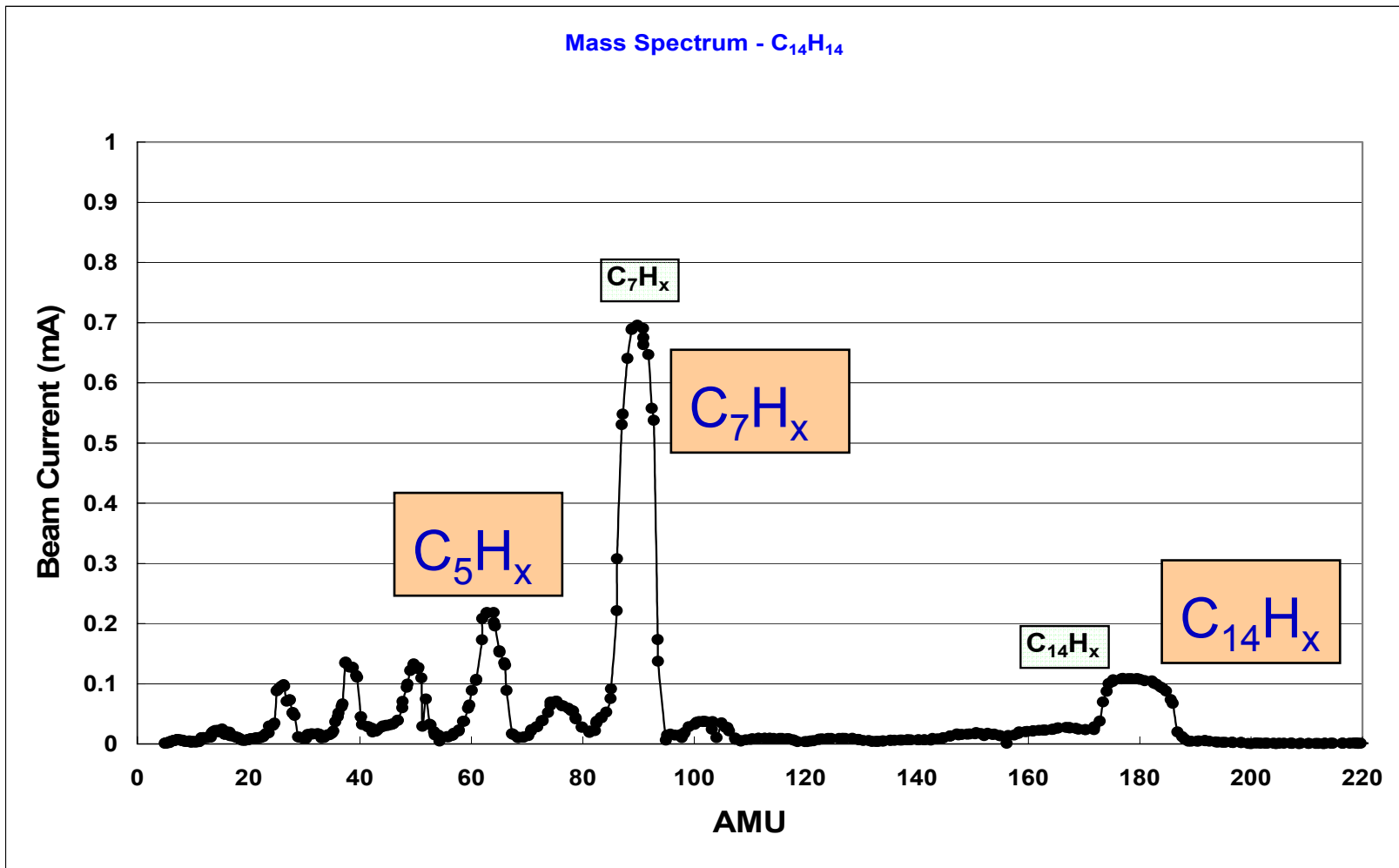


# Introduction

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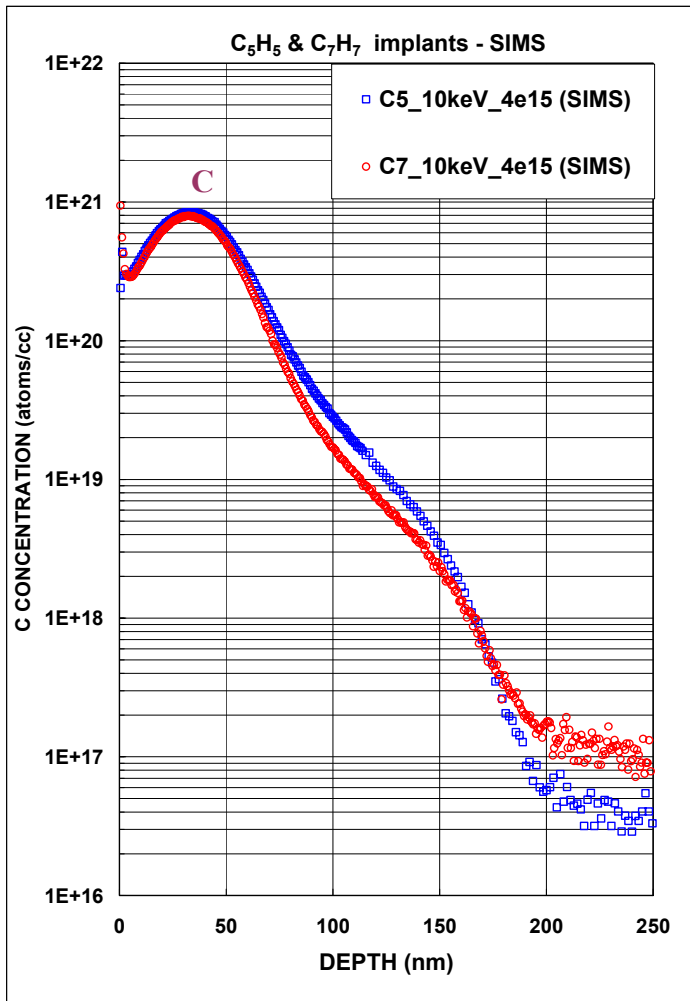
- ClusterCarbon implant is effective process for formation of Si:C stressor
- Previous work used C7 species, but limited to 10keV max energy, or 45nm stressor thickness
- Introducing C5 species allows extension of stressor thickness to >60nm

# Mass Spectrum of $C_{14}H_{14}$ molecule



# ClusterCarbon SIMS Profile - 10keV, 4e15 atoms/cm<sup>2</sup>

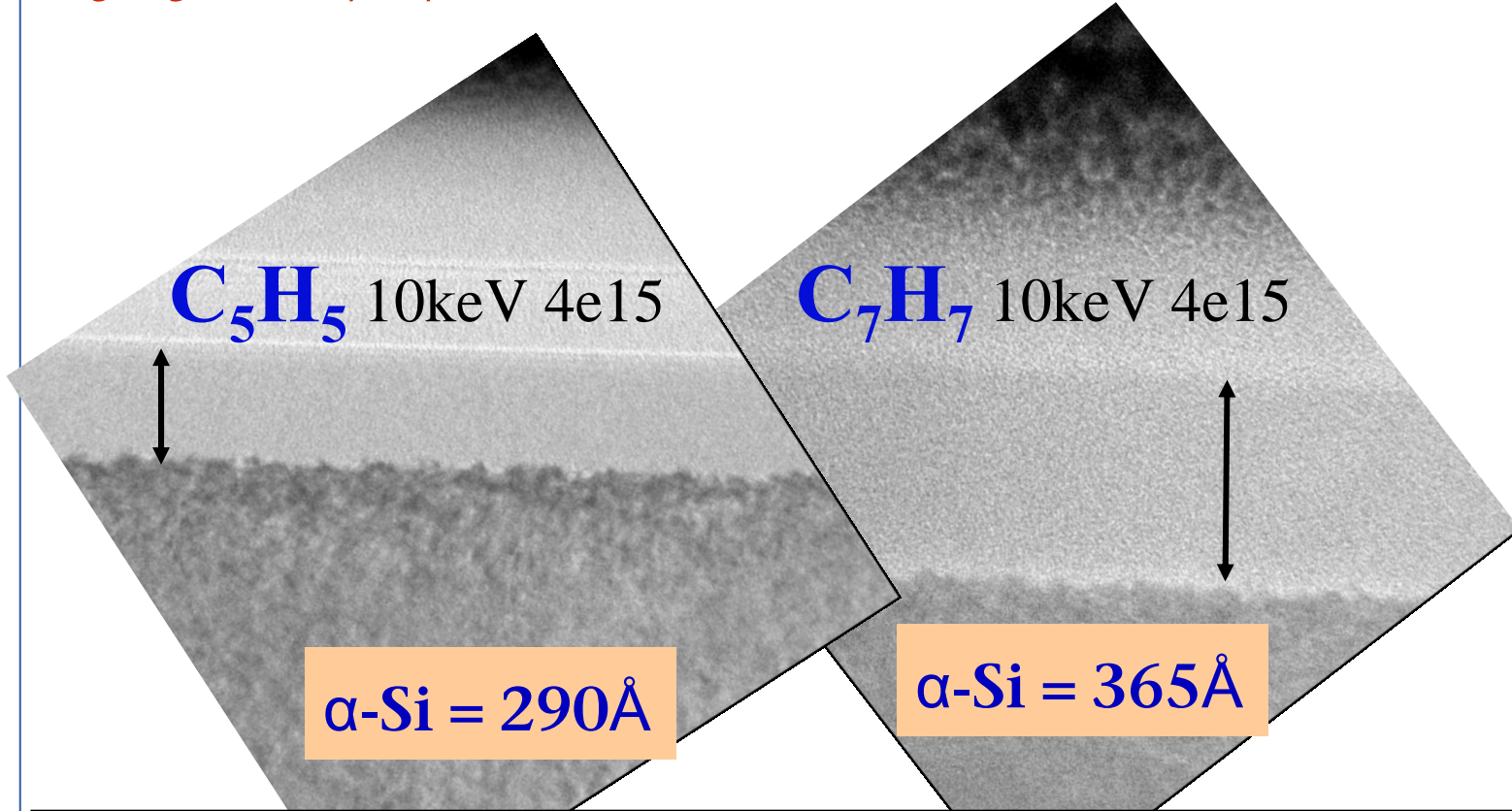
## C<sub>5</sub>H<sub>5</sub> vs C<sub>7</sub>H<sub>7</sub>



- The projected range ( $R_p$ ) for the two species (C<sub>5</sub>H<sub>5</sub> & C<sub>7</sub>H<sub>7</sub>) are identical except for a higher channeling tail for C<sub>5</sub>.

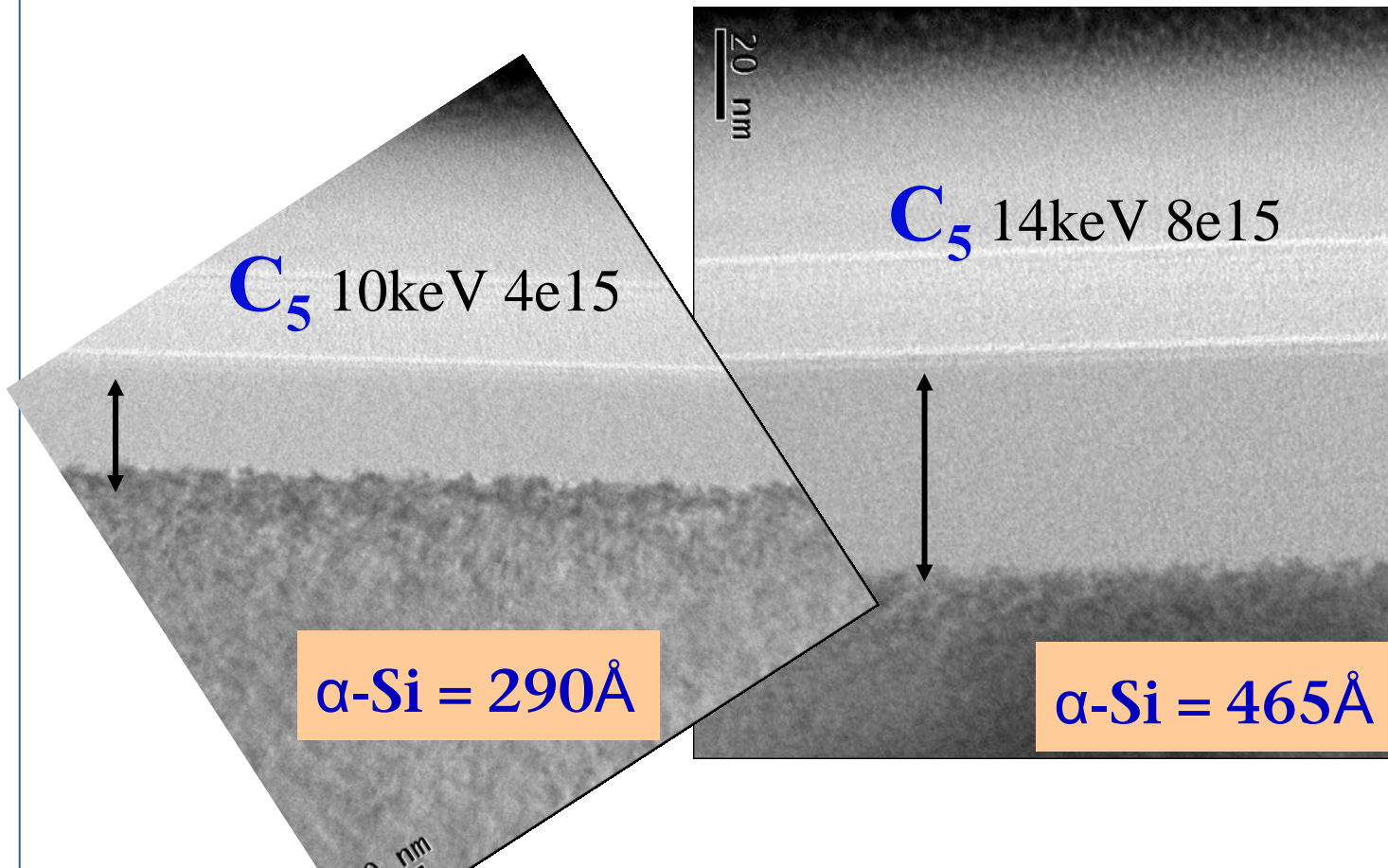
# ClusterCarbon Self-amorphization - 10keV, 4e15 atoms/cm<sup>2</sup>

## C<sub>5</sub>H<sub>5</sub> vs C<sub>7</sub>H<sub>7</sub>



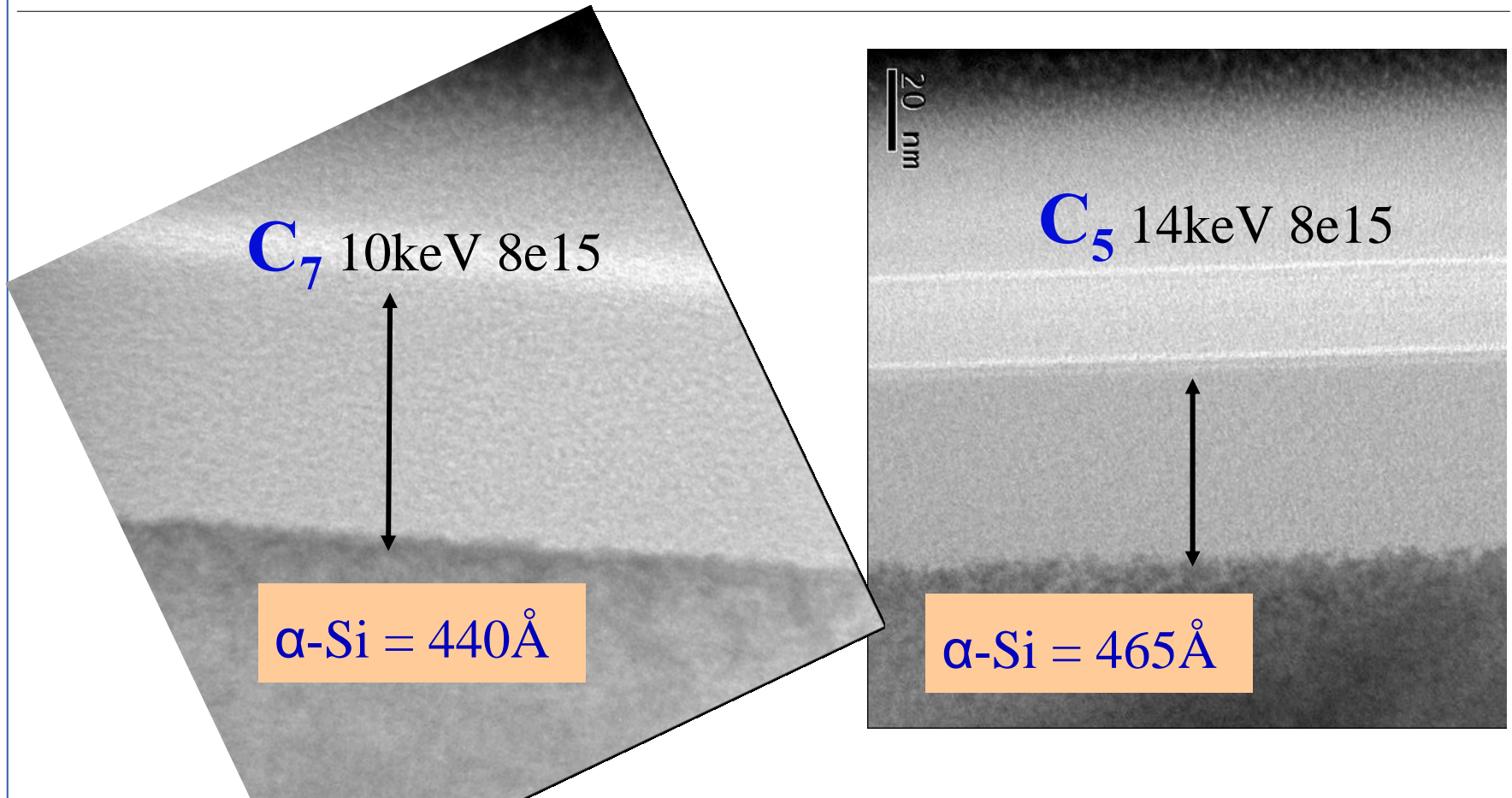
- Going to a higher mass (from C<sub>5</sub> to C<sub>7</sub>) at same implant condition yields about **25% increase** in α-Si layer thickness

# ClusterCarbon C<sub>5</sub>H<sub>5</sub> - Self-Amorphization



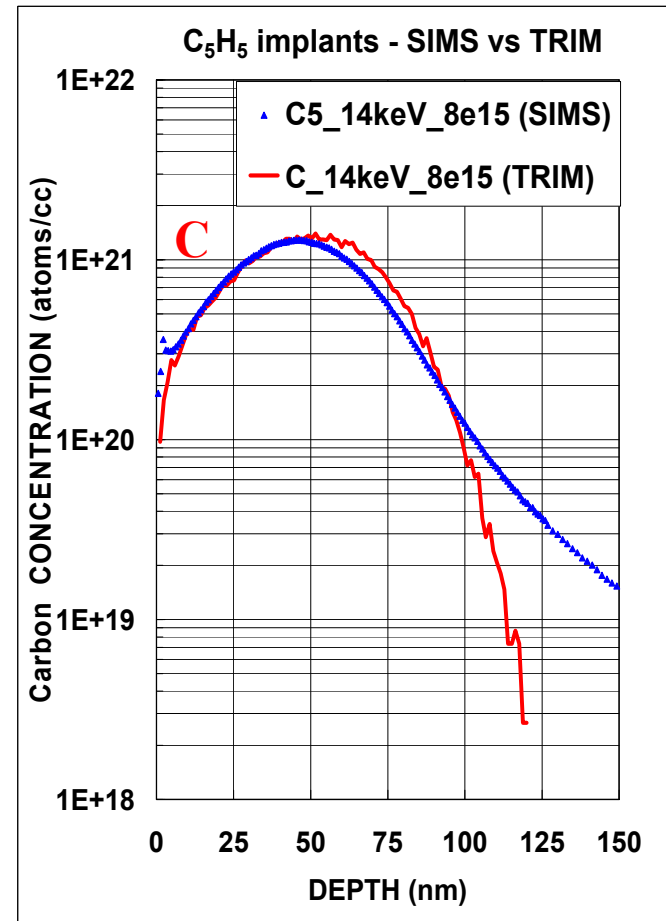
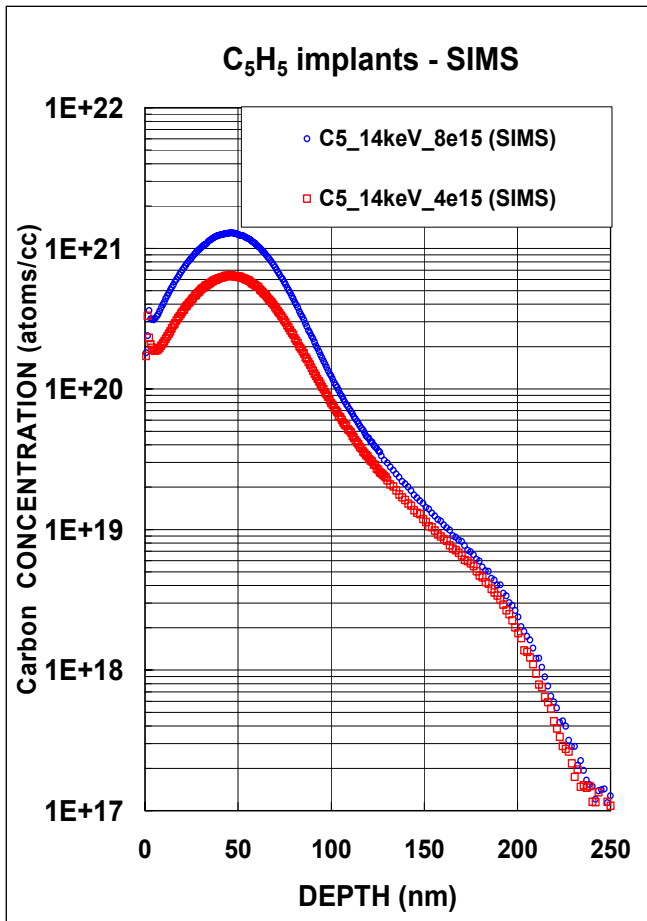
- With higher energy and twice the dose yields only 50% increase in  $\alpha\text{-Si}$  layer

# ClusterCarbon C<sub>5</sub>H<sub>5</sub> - Self-Amorphization



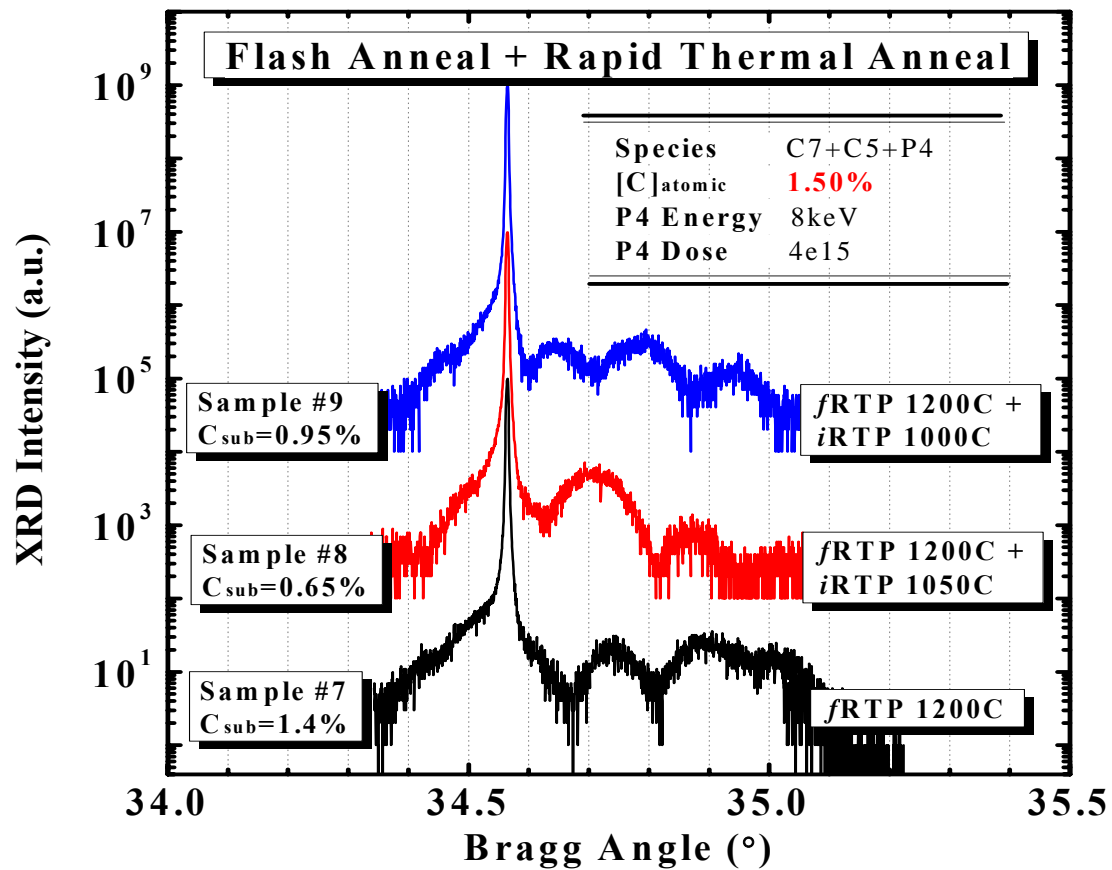
- Even with a higher energy C<sub>5</sub> implant gave just about **5% higher**  $\alpha\text{-Si}$  layer

# C<sub>5</sub>H<sub>5</sub> implant – SIMS & TRIM Profile



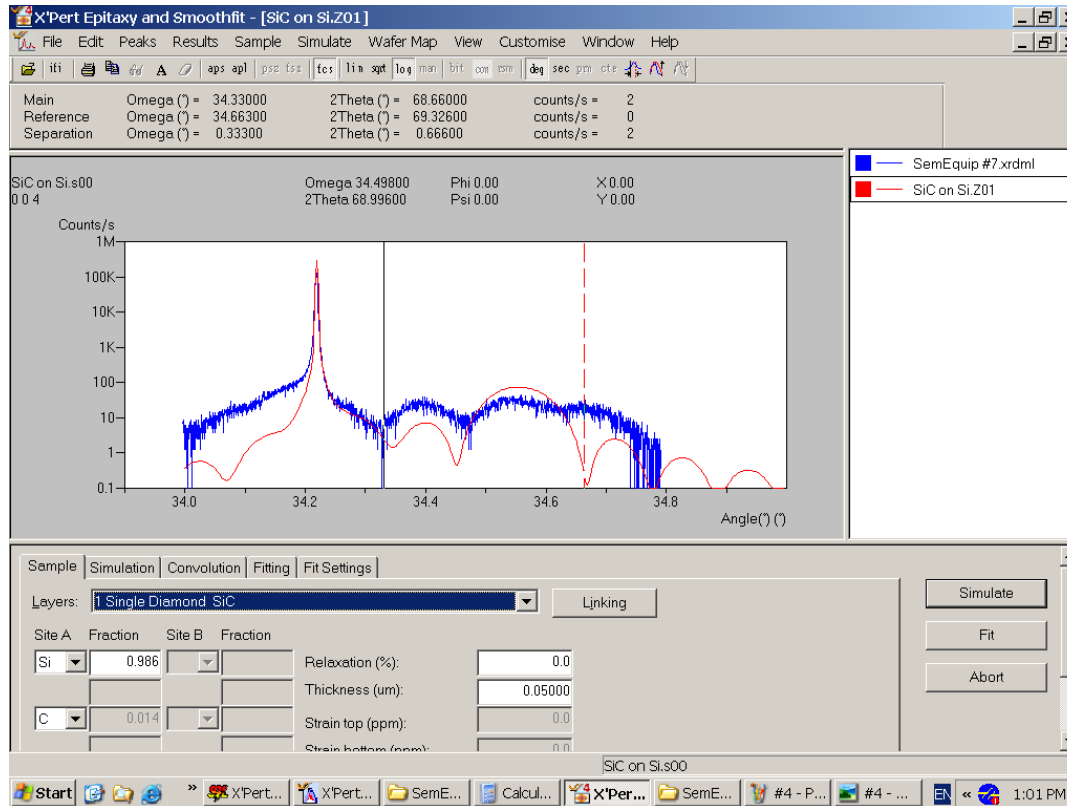
- Actual SIMS profile and simulated TRIM profile more or less agree very well.

# HRXRD Results

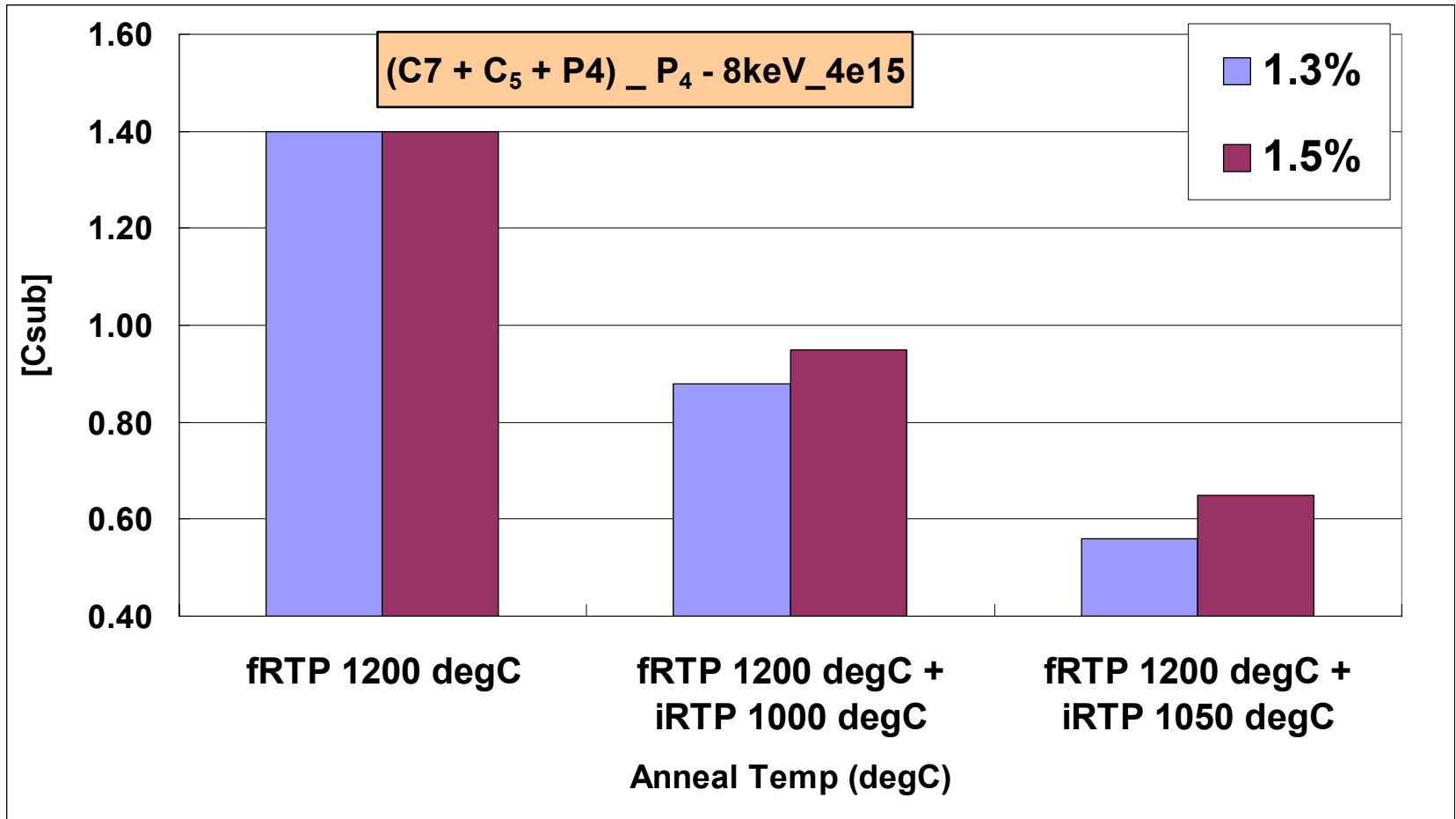


# HRXRD Results, model

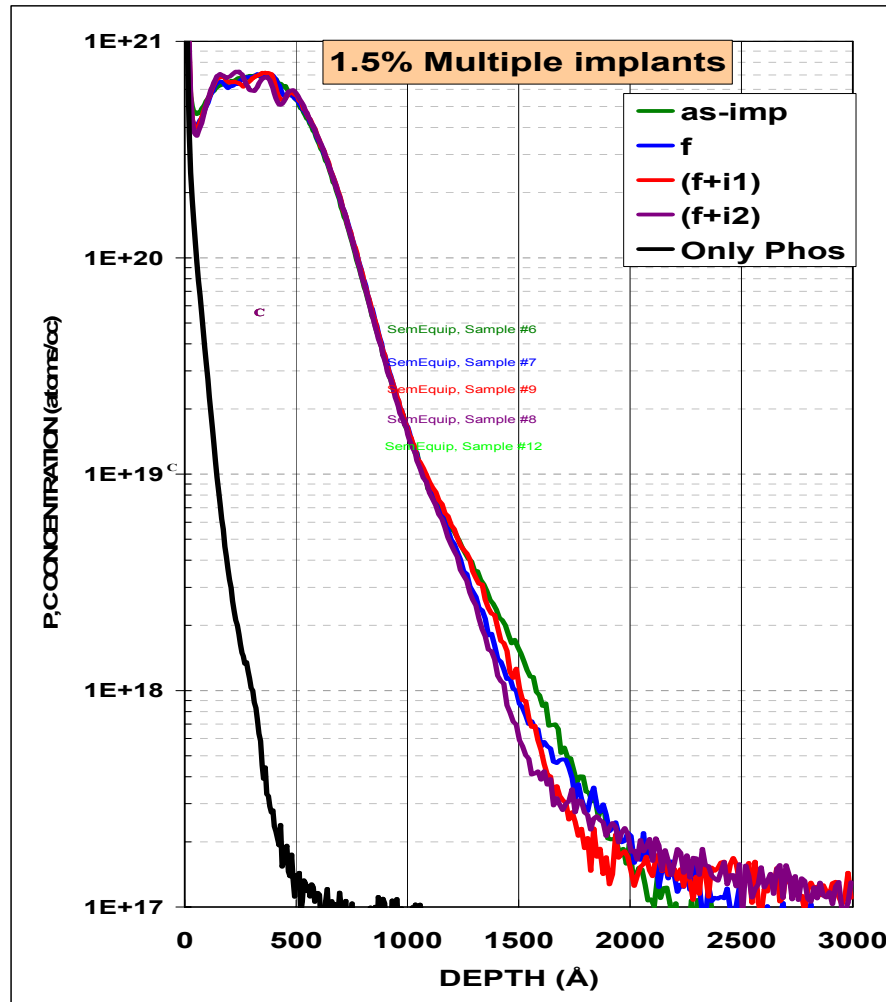
$[C_{sub}] = 1.4\%$ , *thickness* Si:C=50nm



# Carbon substitutionality vs. anneal

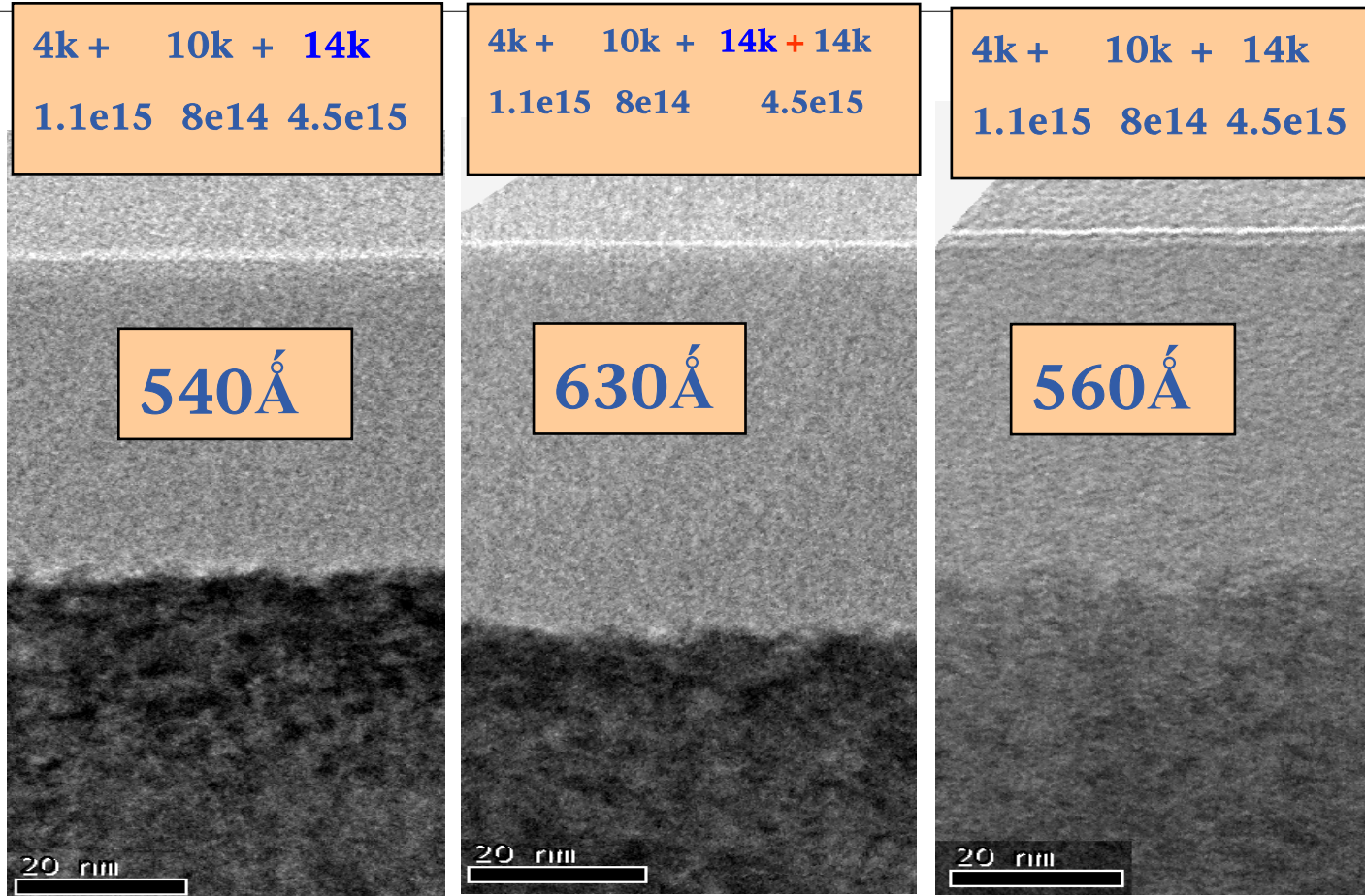


# SIMS Profile



# Multiple implants with $C_7$ & $C_5$

x100k



# Summary

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- **C5 allows stressor thickness to be increased to >60nm**
  - Only works with multiple implant sequence
- **High Carbon Substitutional fraction achieved.**
  
- **Please see oral presentation Th-14 for more information about ClusterCarbon Stressors**

# Enhancement of Amorphous layer thickness

