

# Reversible Optical Recording on Epitaxial Indium Selenide Phase-Change Media

A. Chaiken, G.A. Gibson, K. Nauka, C.C. Yang, B.S. Yeh, R. Bicknell, J. Chen, H. Liao, S. Subramanian and D.D. Lindig

*Hewlett-Packard*

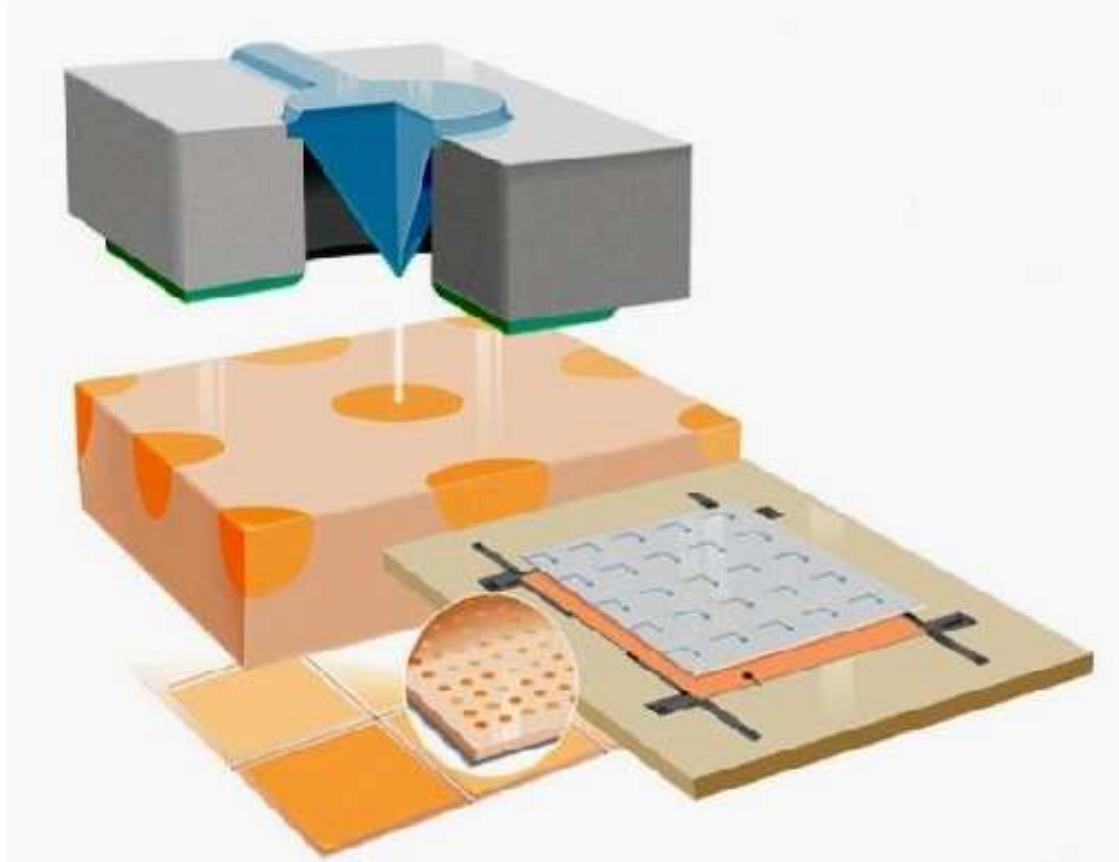
J.B. Jasinski and Z. Liliental-Weber  
*Lawrence Berkeley National Lab*



i n v e n t

# Electron-Beam Recording on Phase-Change Media

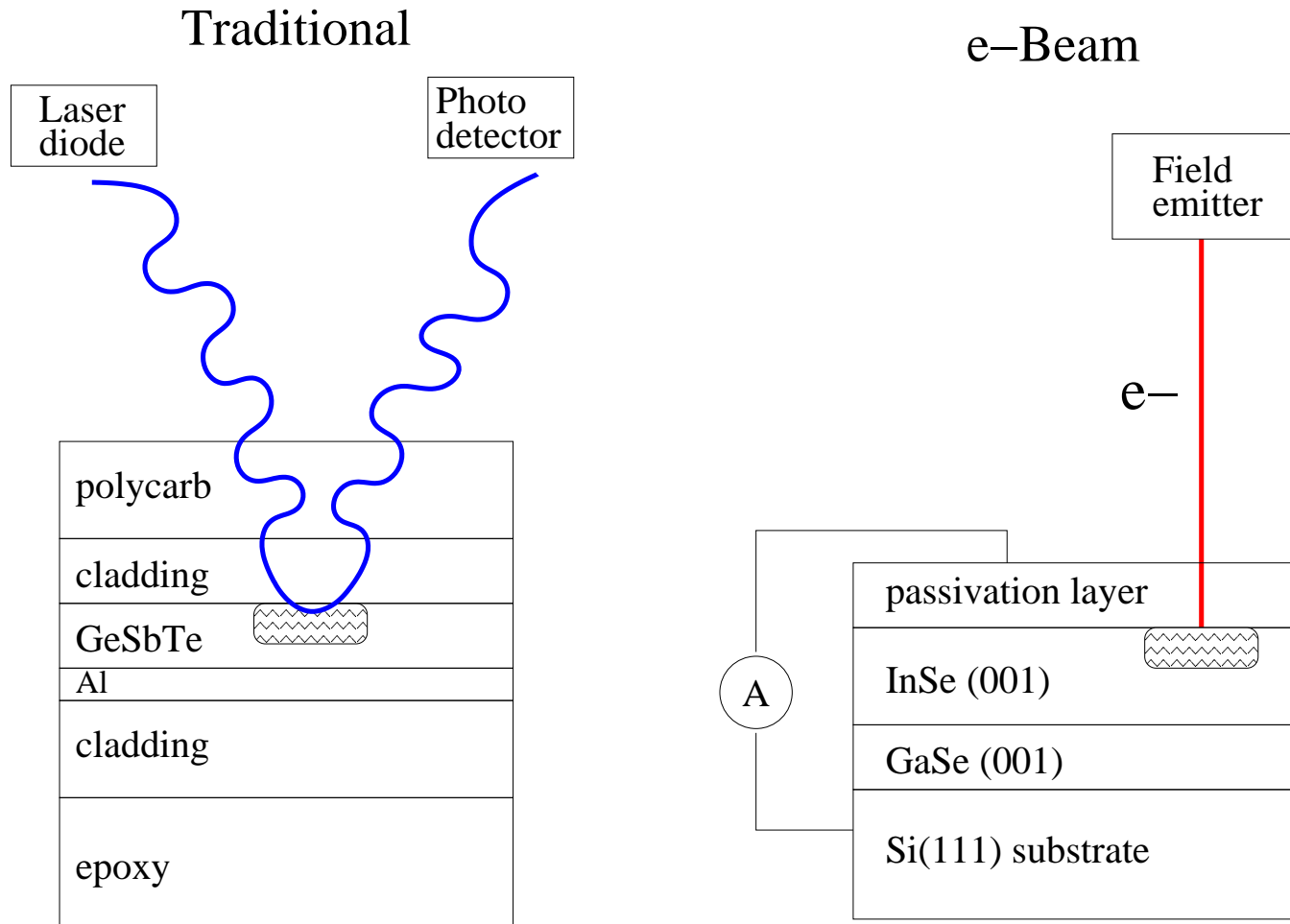
---



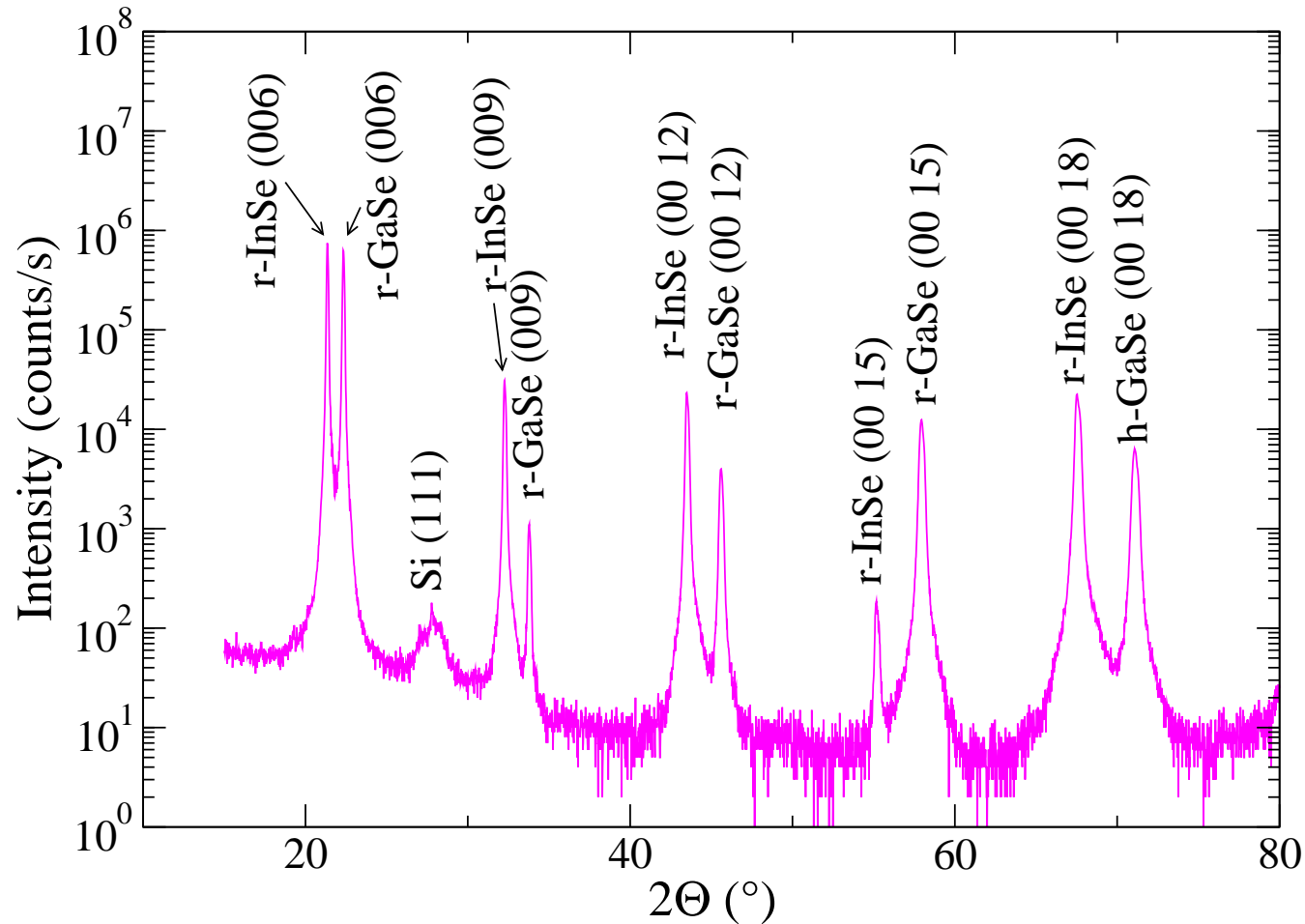
From **Scientific American**, March 2000.

See also S.-T. Lam, *J. Vac. Sci. Techn.* **21**, 479 (2003).

# Optical vs. Electron-Beam Recording



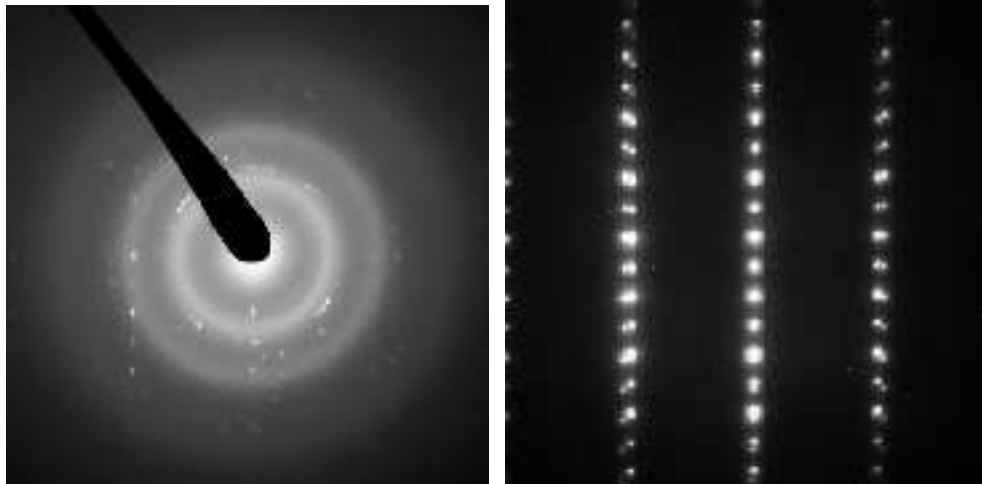
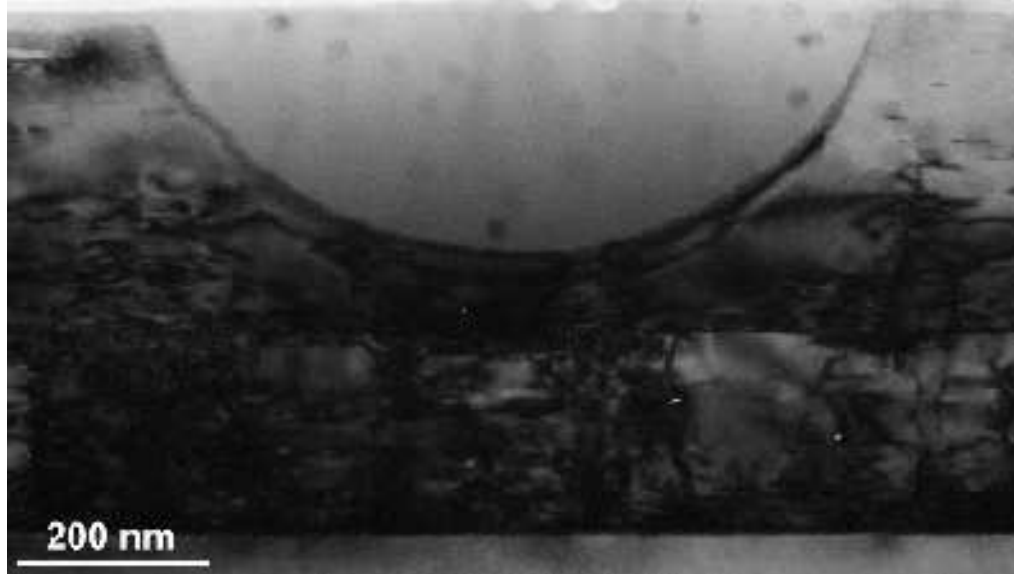
# Good Quality Epitaxial InSe/GaSe/Si(111) Films



Phase-change materials with decent semiconducting properties that grow well on Si!

# Amorphous Laser Marks

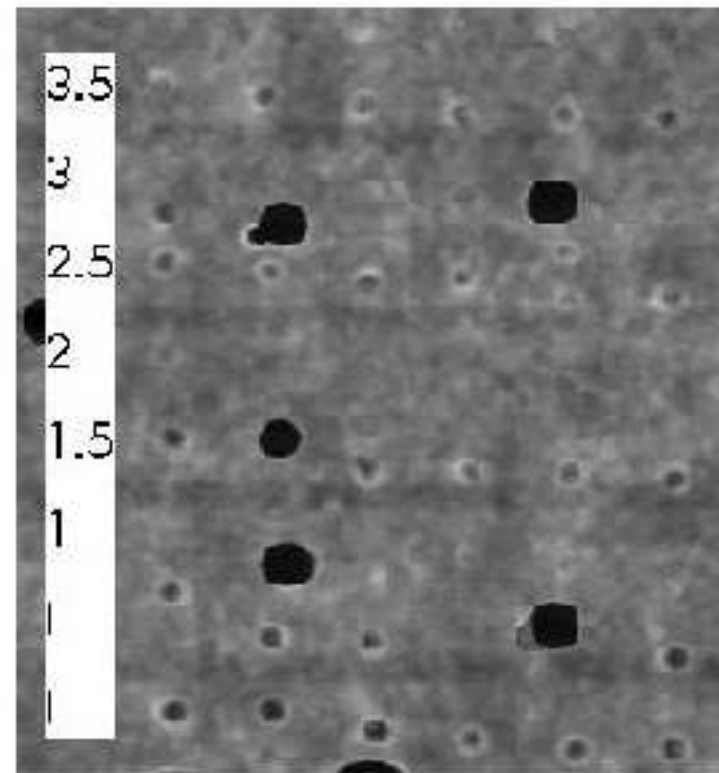
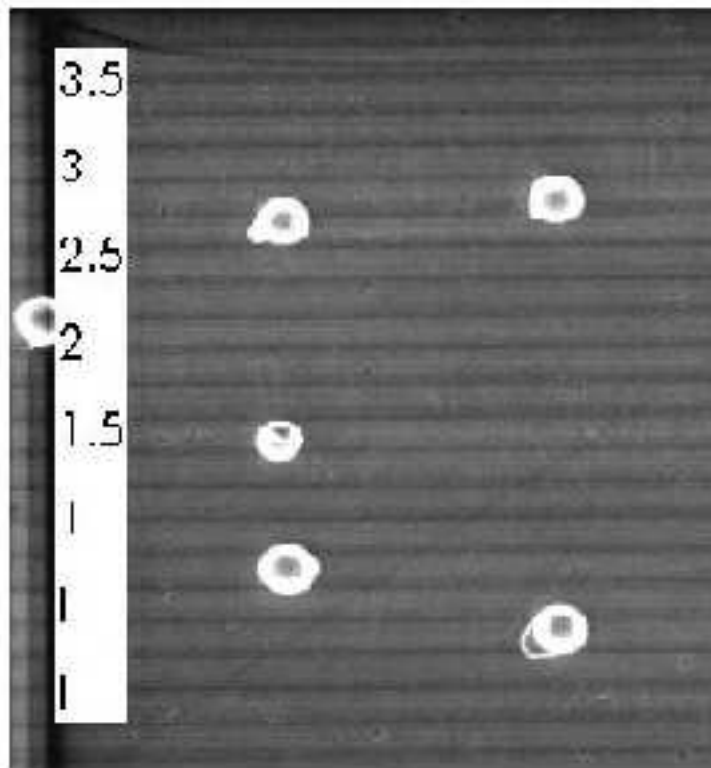
---



Laser used to simulate e-beam recording.

# Electronic Contrast and Erasure Observed without Surface Damage

---

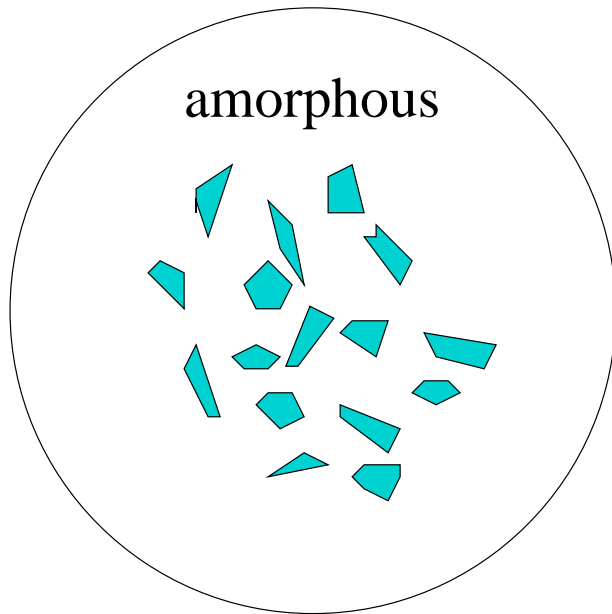


I = Write pulse; 1 = Write/Erase; 1.5 = WEW ...  
Up to 100 cycles with only minor degradation.

# Scaling of Erasure Time Depends on Recrystallization Mode

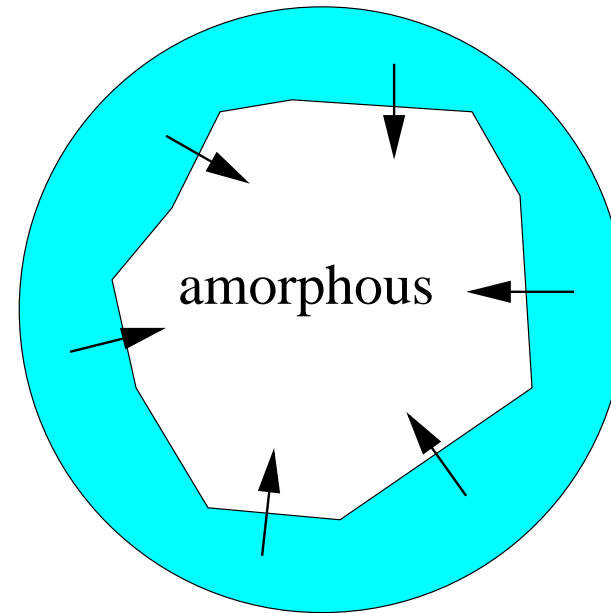
---

Homogeneous nucleation  
plus growth



Like GeSbTe

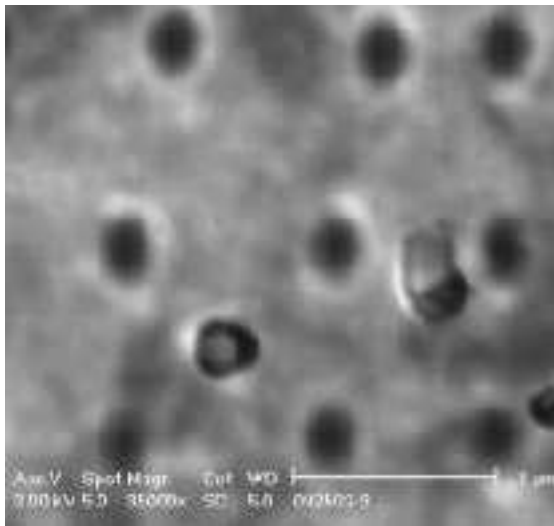
Regrowth from crystalline matrix  
without nucleation



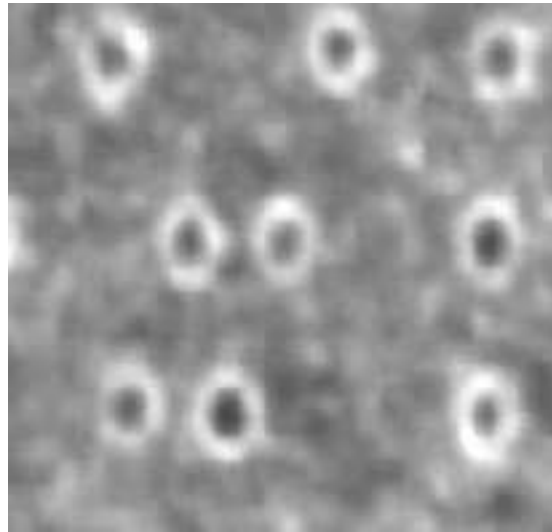
Like InAgSbTe

# Some Evidence for Regrowth from the Matrix

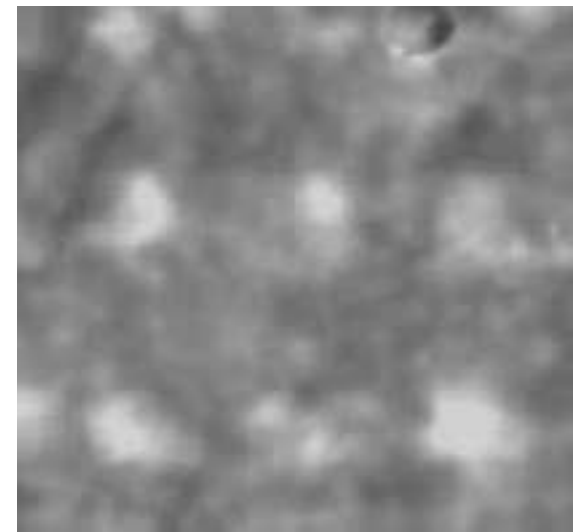
---



Write pulse only



Write + 10  $\mu$ S erase



Write + 100  $\mu$ S erase

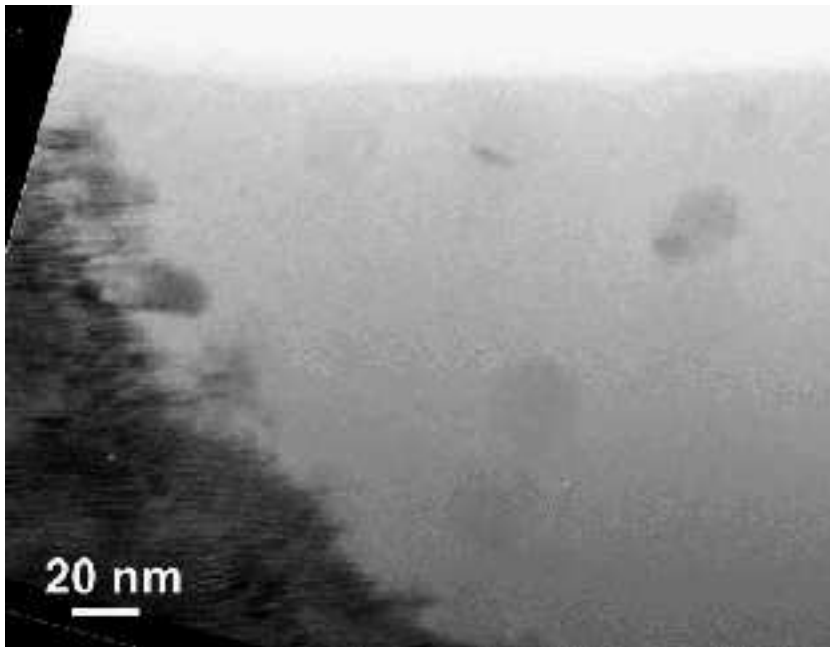
As erase pulse lengthens, bright ring grows inward.

Final mark has larger signal than surrounding matrix.

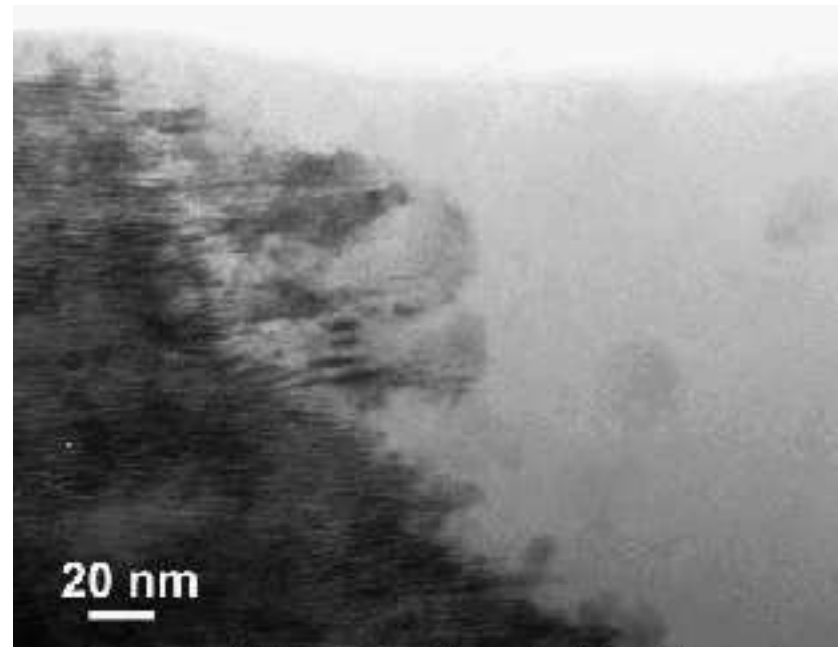


# In Situ TEM Recrystallization Occurs from Mark Edge

---



Write pulse only



Write + 1 S irradiation

*In situ* TEM observation of electron-beam exposure suggest re-growth from the edge.

Growth-dominant behavior can occur under some circumstances.

# Summary

---

- High-quality phase-change media films have been grown on Si(111).
- The III-VI semiconductor phase-change media form diodes with reasonable collection efficiency.
- Erasable laser marks give a usable contrast in diode signal.
- Apparent growth-dominant behavior implies short erasure time for small-diameter marks.
- Up to 100 write-erase cycles have been achieved without significant degradation.

## More Information

---

HH2.6 **An Electron-Beam Addressed Phase-Change Recording Medium**, Gary Gibson, HP, 3:45 today.

HH3.7 **Modeling InSe Phase-Change Materials**, Krisztian Kohary, Oxford, 11:30 Tuesday.

GG4.5 **Heteroepitaxy of InSe/GaSe on Si(111) Substrates**, Jacek Jasinski, LBNL, 3:45 Wednesday.

Also a preprint, **Electronic detection of reversible optical recording on epitaxial InSe/GaSe/Si diodes.**