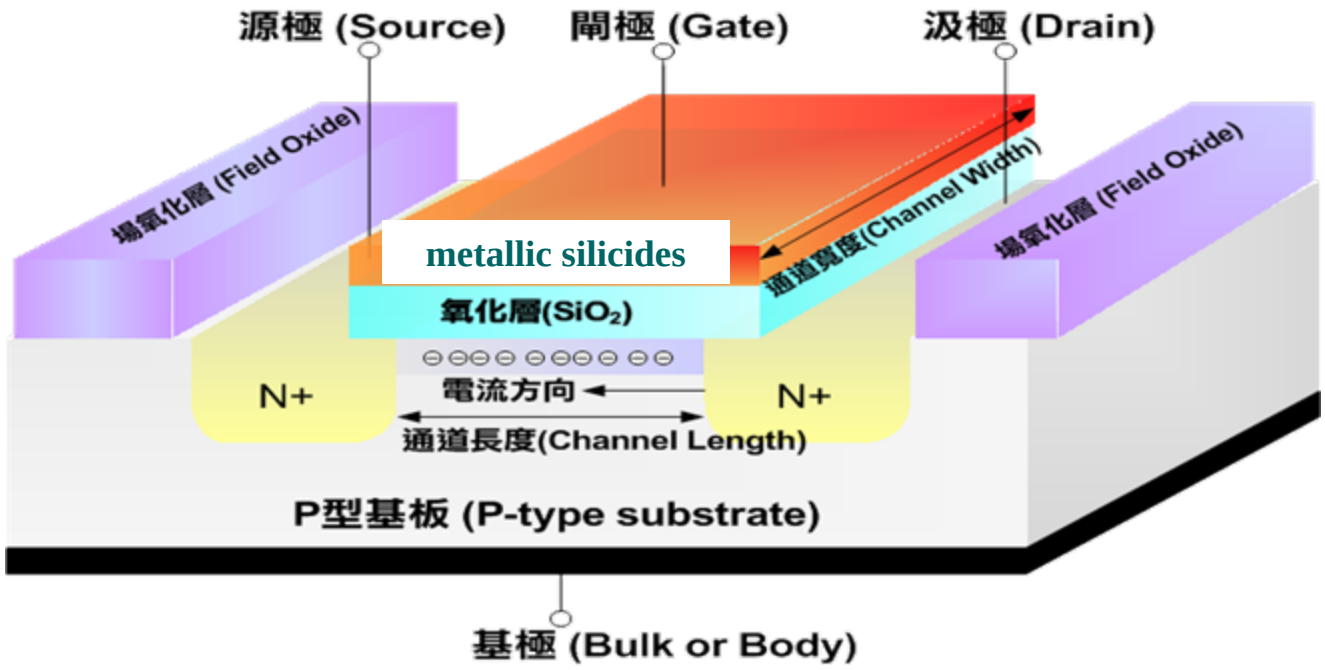
High temperature testing of $TiSi_2$ by Nanoindenter

二矽化鈦高溫奈米壓痕機性測試

Metallic silicides applied in semiconductor

- **High-temperature stability.**
- Schottky barriers and ohmic contacts.
- Low resistivity for gates and interconnects.
- Easy to etch for pattern generation.



Purpose of this study

- Nanostructured material with grain sizes (<100nm)

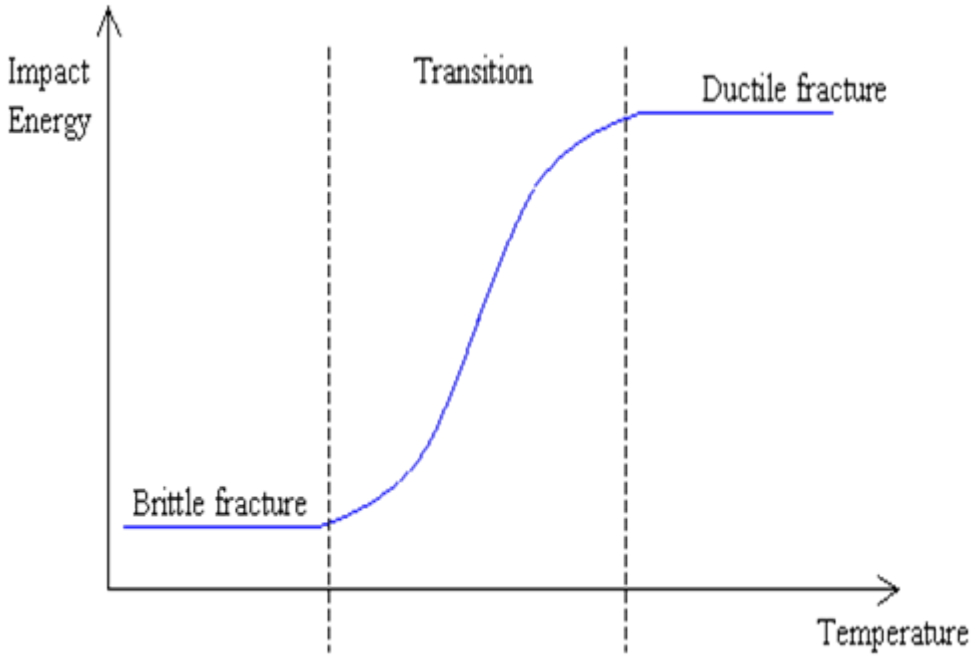
- Grain size decreasing,
  lowing temperature superplastic.
  increasing ductility by Hall-Petch equation.

- Compared the difference of ductile brittle transition temperature (DBTT) for $TiSi_2$ bulk and thin film.

V. Provenzano R. Valiev D.G. Rickerby G.Valdre, nanostructures mater, 12(1999), pp.1103-1108

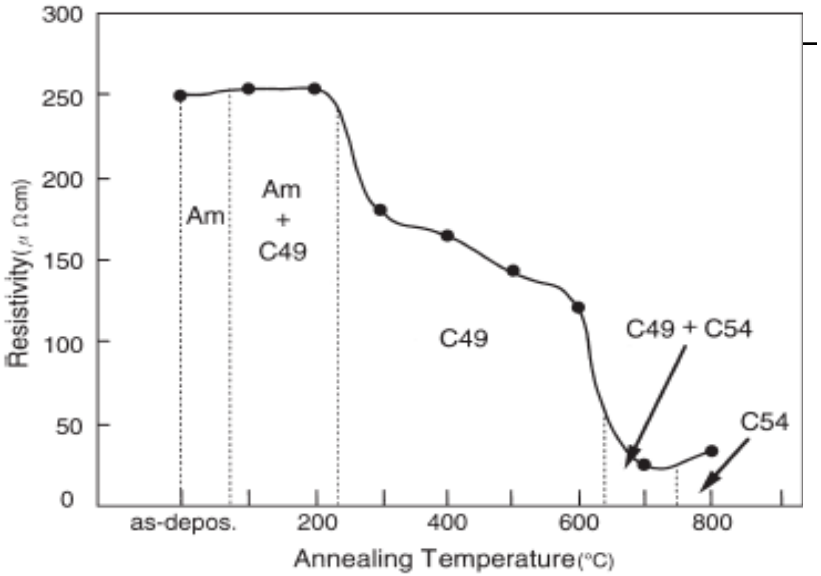
Ductile-Brittle Transition Temperature

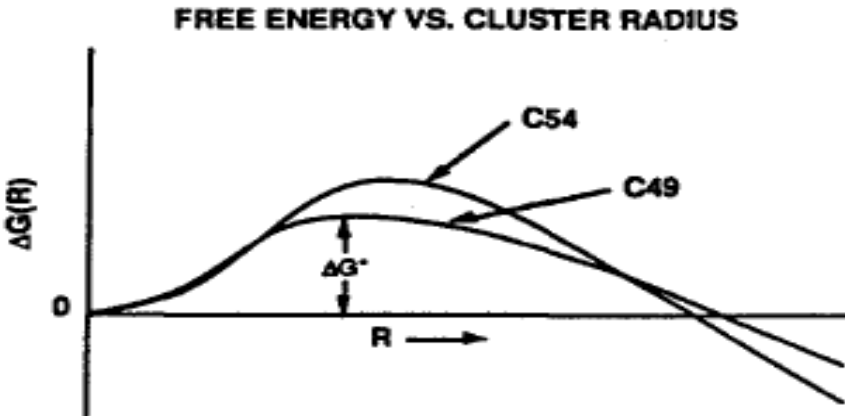
- A sudden and dramatic drop in the energy absorbed by a metal subjected to impact loading.



http://www.doitpoms.ac.uk/tlplib/ductile-brittle-transition/ductile-to-brittle.php

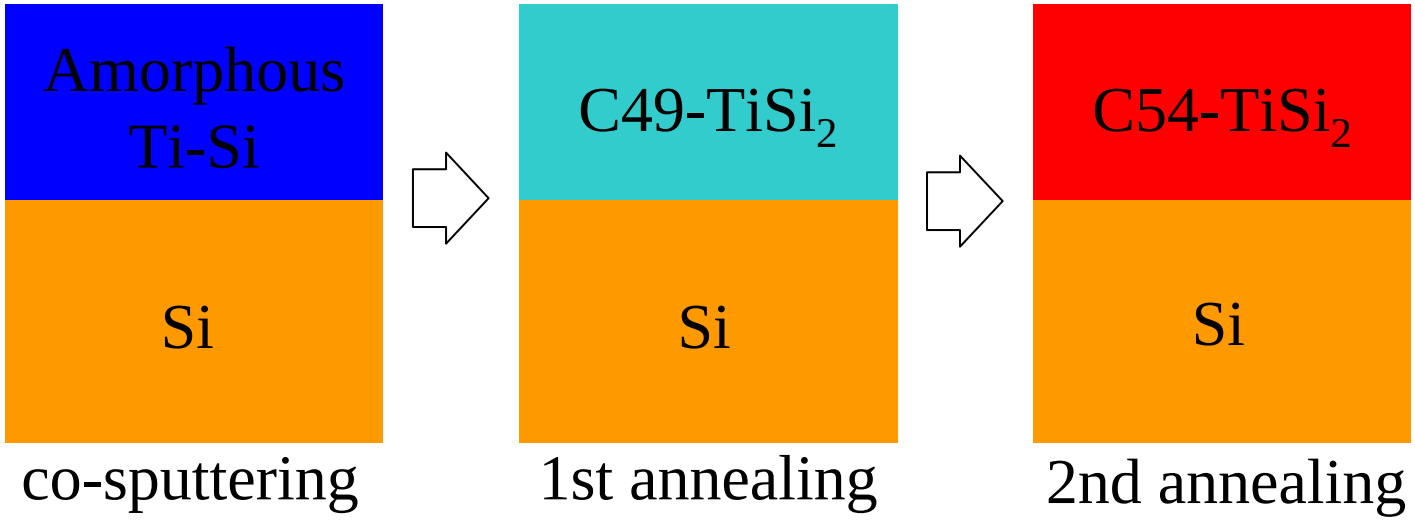
$TiSi_2$ films fabrication



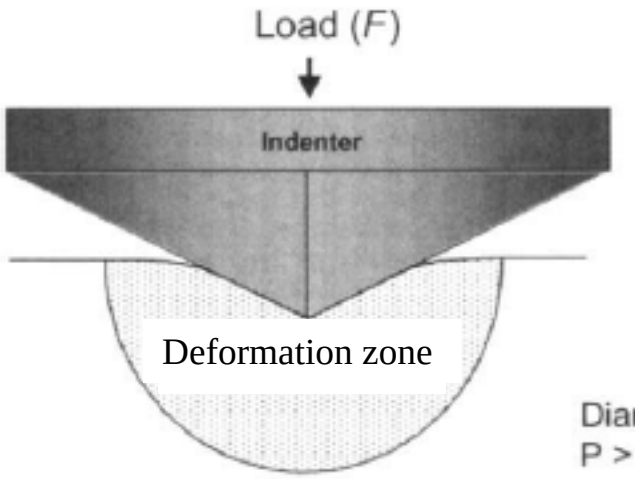


K. Maex, Mater. Sci. & Eng. R., 11 (1993), pp. 53-153.

H. Inui, T. Hashimoto, K. Tanaka, T. Mizoguchi, H.adachi, and M. Yamaguchi, Acta mater., 49 (2001), pp. 83-92.



Nanoindentation testing

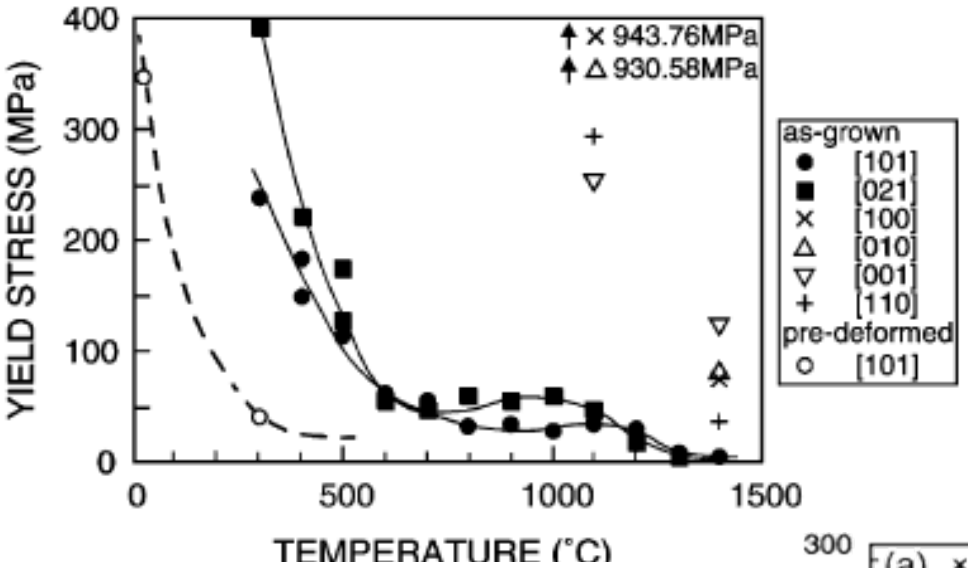


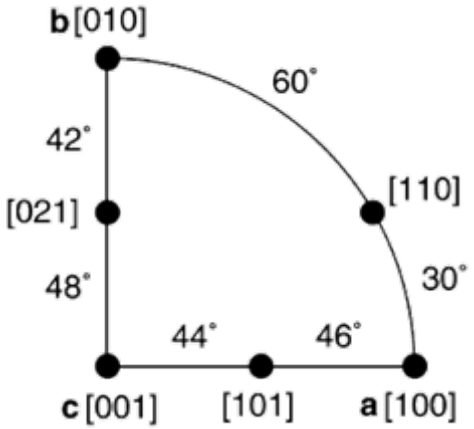
p* = *F*/*S, where
p is pressure
F is force
S is contact area

Diamond/diamond couple:
P > 100 GPa (1 Megabar)

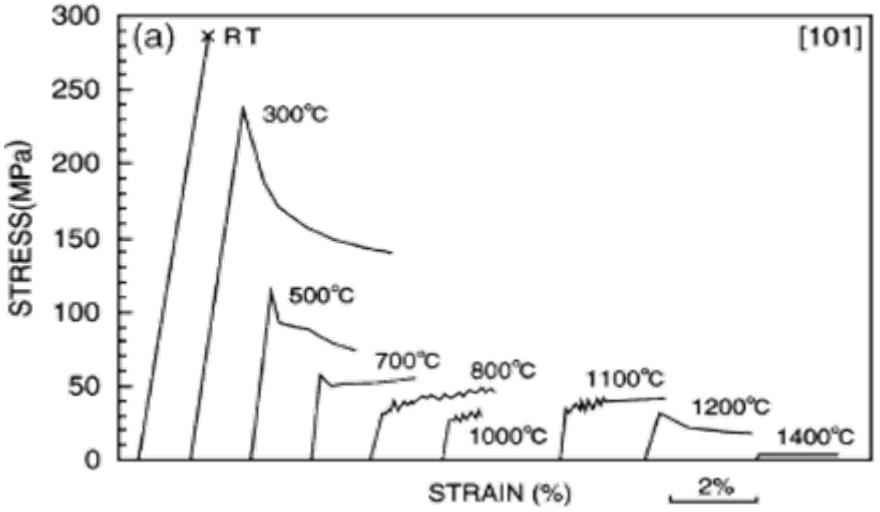
- **The C49- and C54-$TiSi_2$ examined with different temperatures and grain sizes.**
- Temperature range from 100 to 400^{o}C
- The grains size range from 10 nm to 100 nm

$TiSi_2$ single crystal bulk

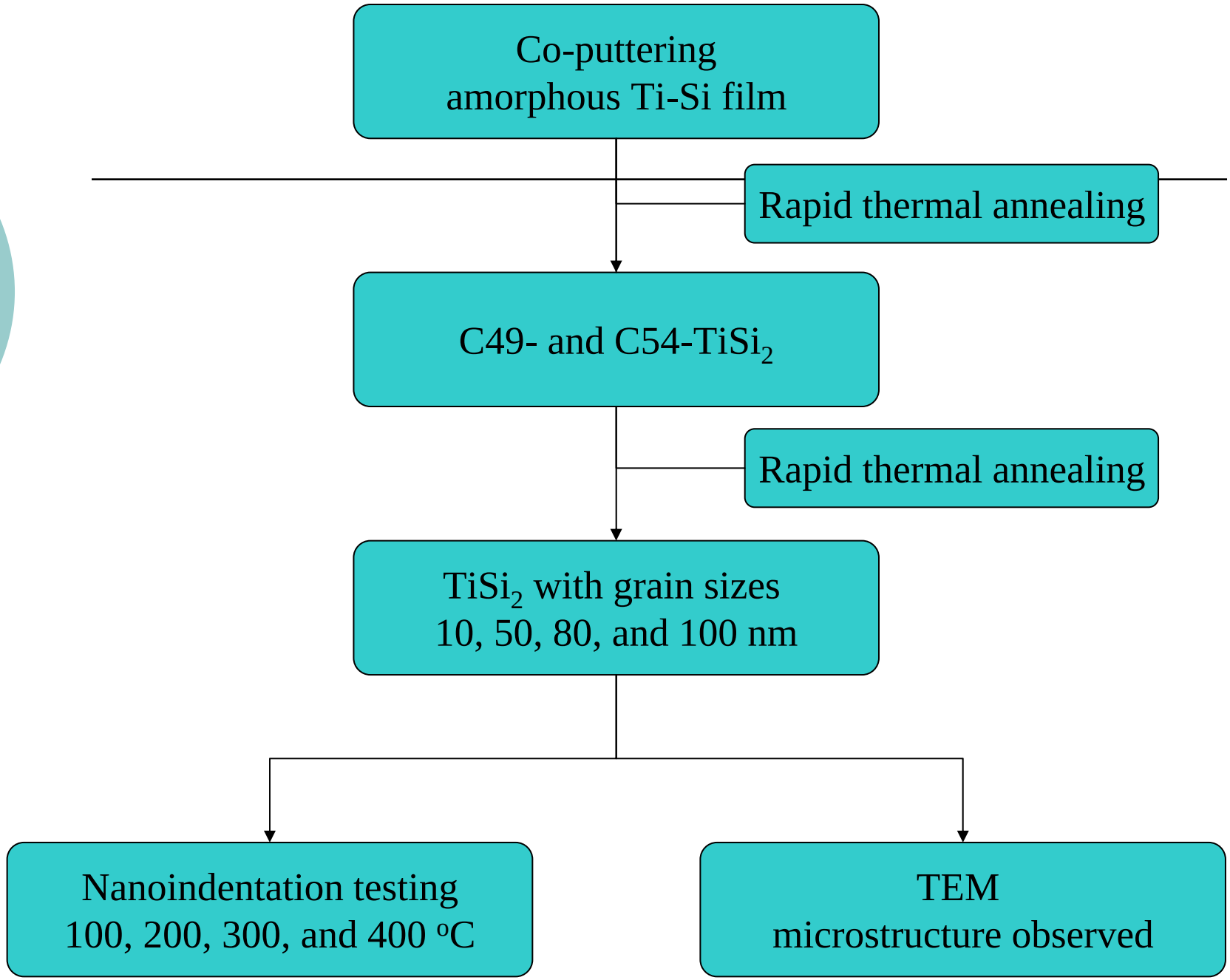




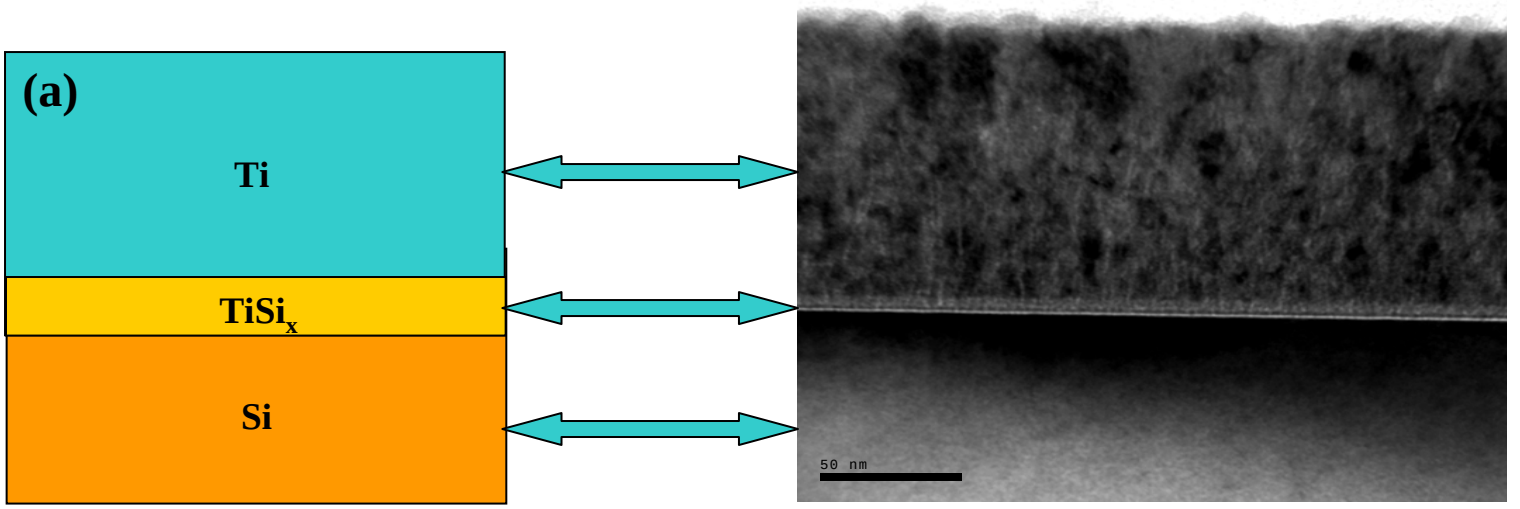
The $TiSi_2$ single crystal compressed with axes [001], [100], [010], [110], [101], and [021].

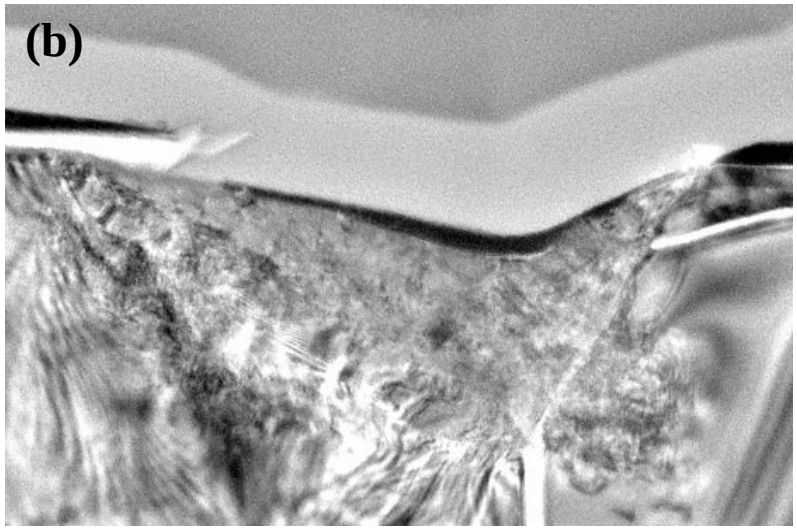


H. Inui, M. Moriwaki, N. Okamoto, M. Yamaguchi, Acta mater, 51(2003), pp. 1409-1420.


Co-puttering
amorphous Ti-Si film
Rapid thermal annealing
C49- and C54-TiSi2
Rapid thermal annealing
TiSi2 with grain sizes
10, 50, 80, and 100 nm
Nanoindentation testing
100, 200, 300, and 400 oC
TEM
microstructure observed

$TiSi_2$ nanocrystal thin film





(a) The Ti-Si films without deformation

(b) The Ti-Si films with deformation