Study of Group IV Elemental Couples at Lower Dimensions

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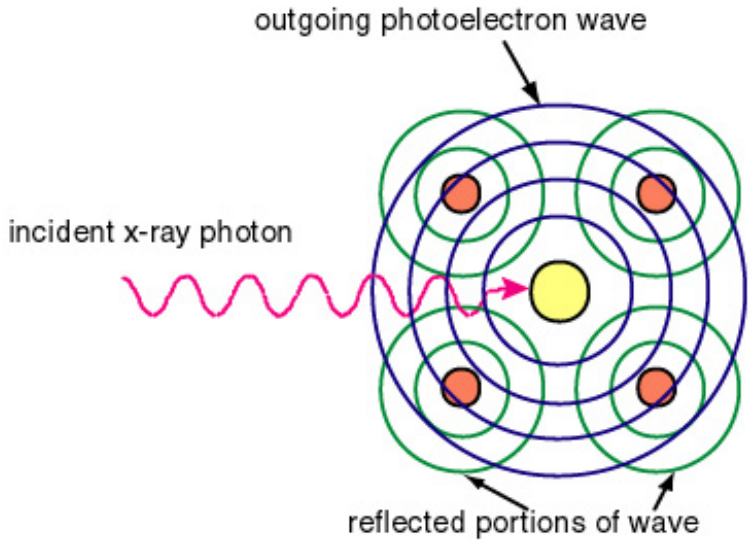
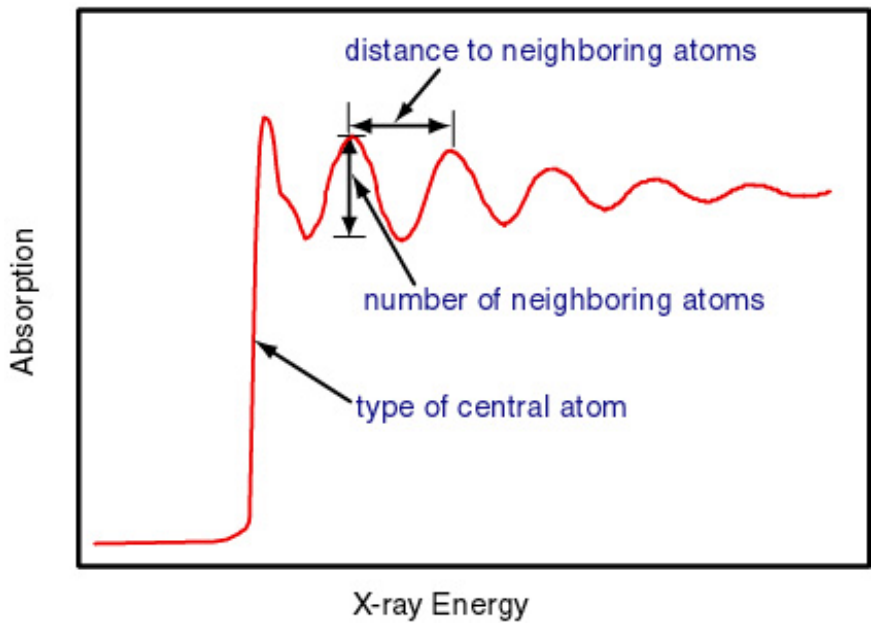
Preparation of nano-scale Sn-Ge powders using mechanical milling with varying Sn/Ge atomic composition

- Milling of 40, 30 and 20 at% Sn/Ge powders long durations for 24 - 36 hrs in Argon atmosphere
- Maintain an average size by sieving

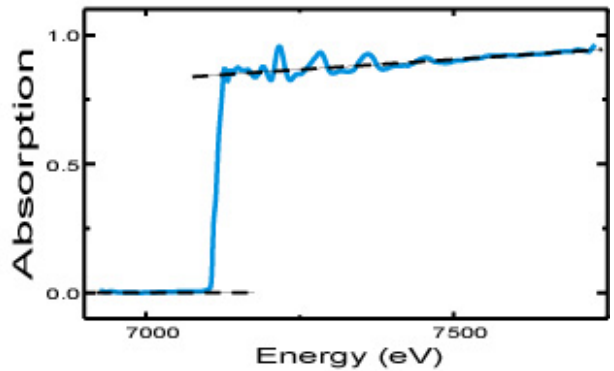
XAFS: X-ray Absorption Fine Structure



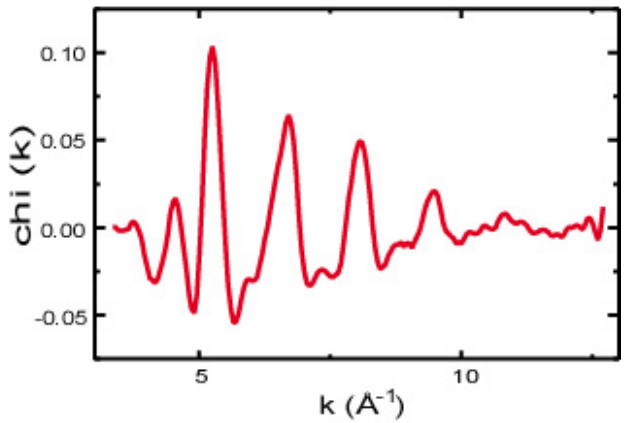


Analysis of XAFS Spectra

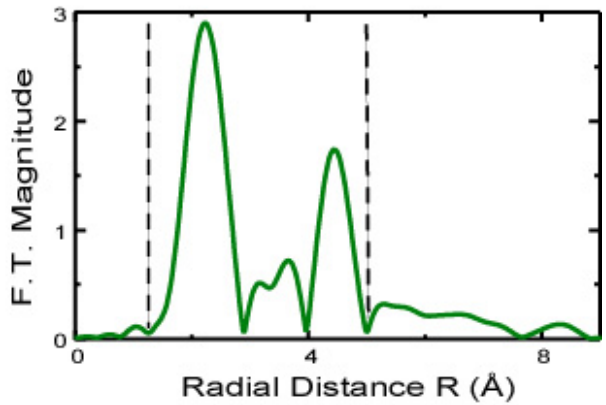
- background removal

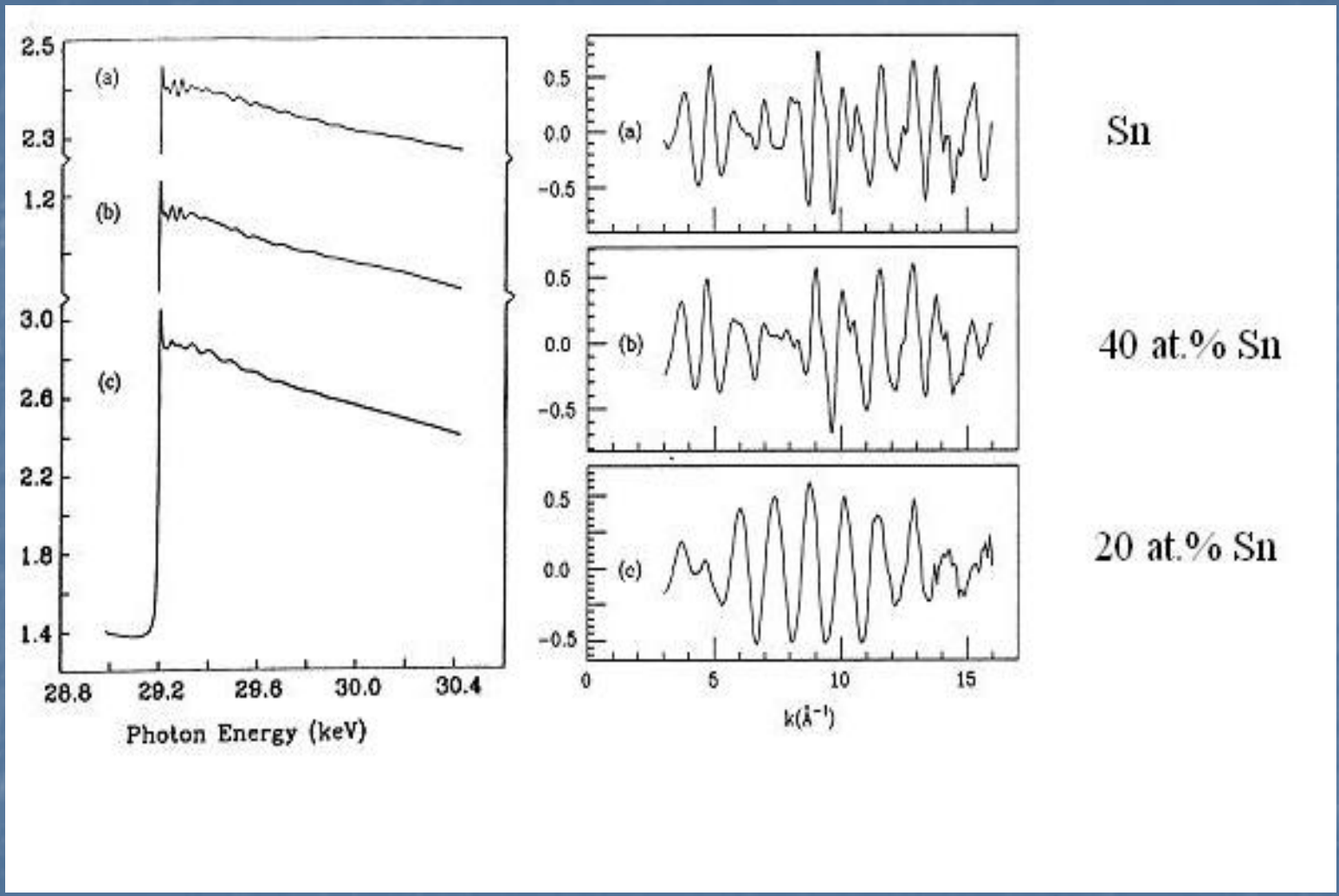


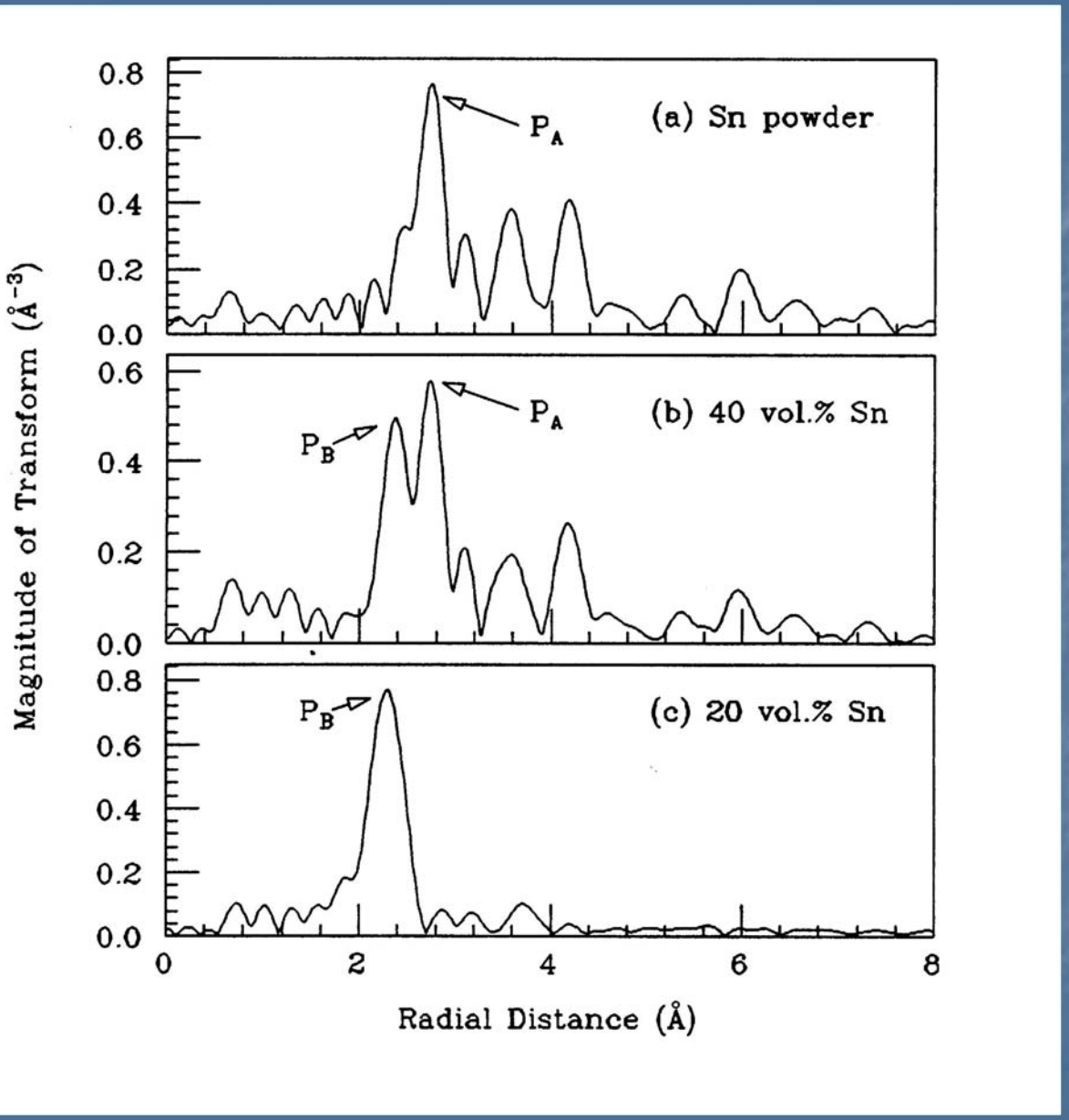
- isolated extended XAFS

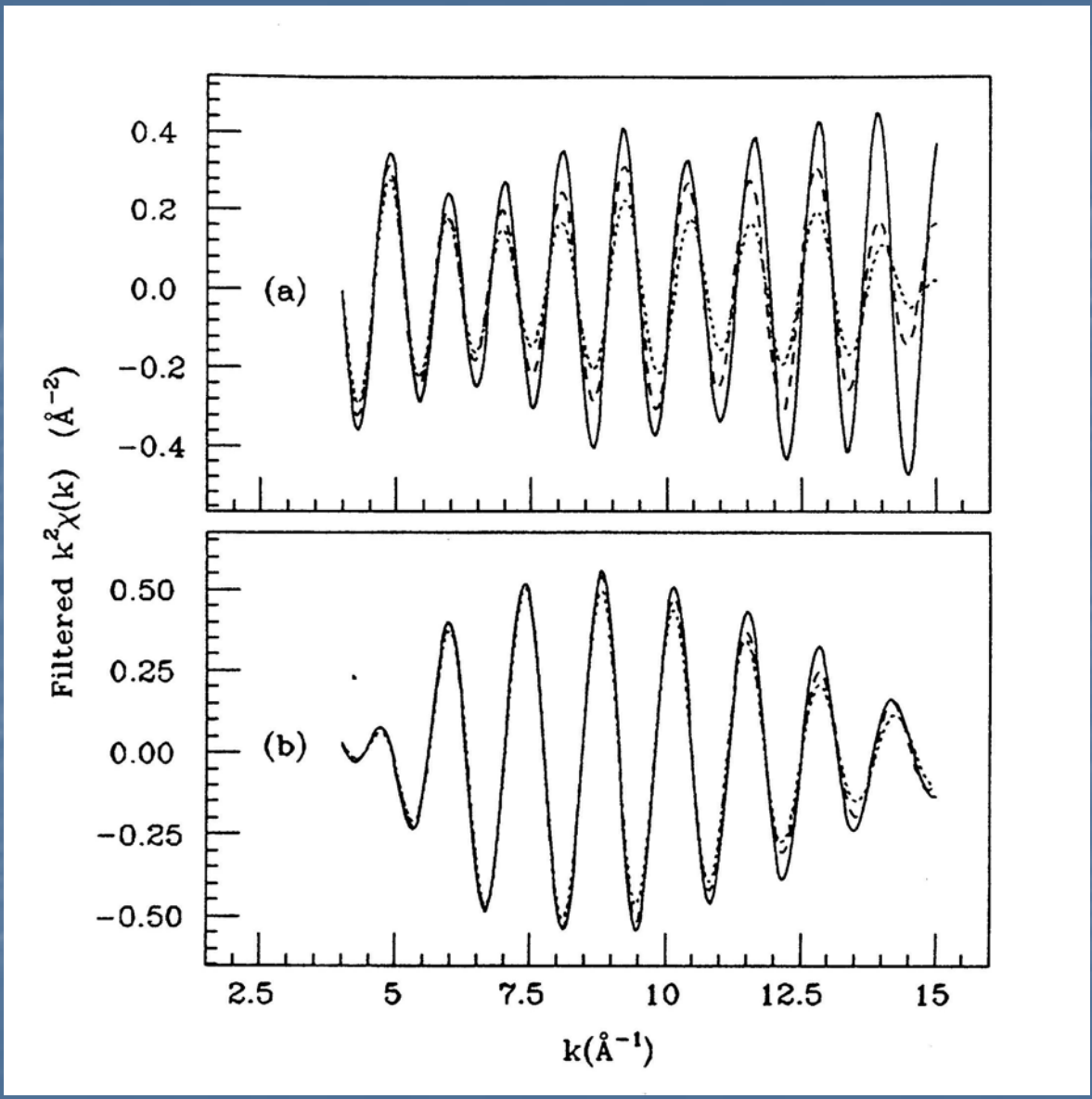


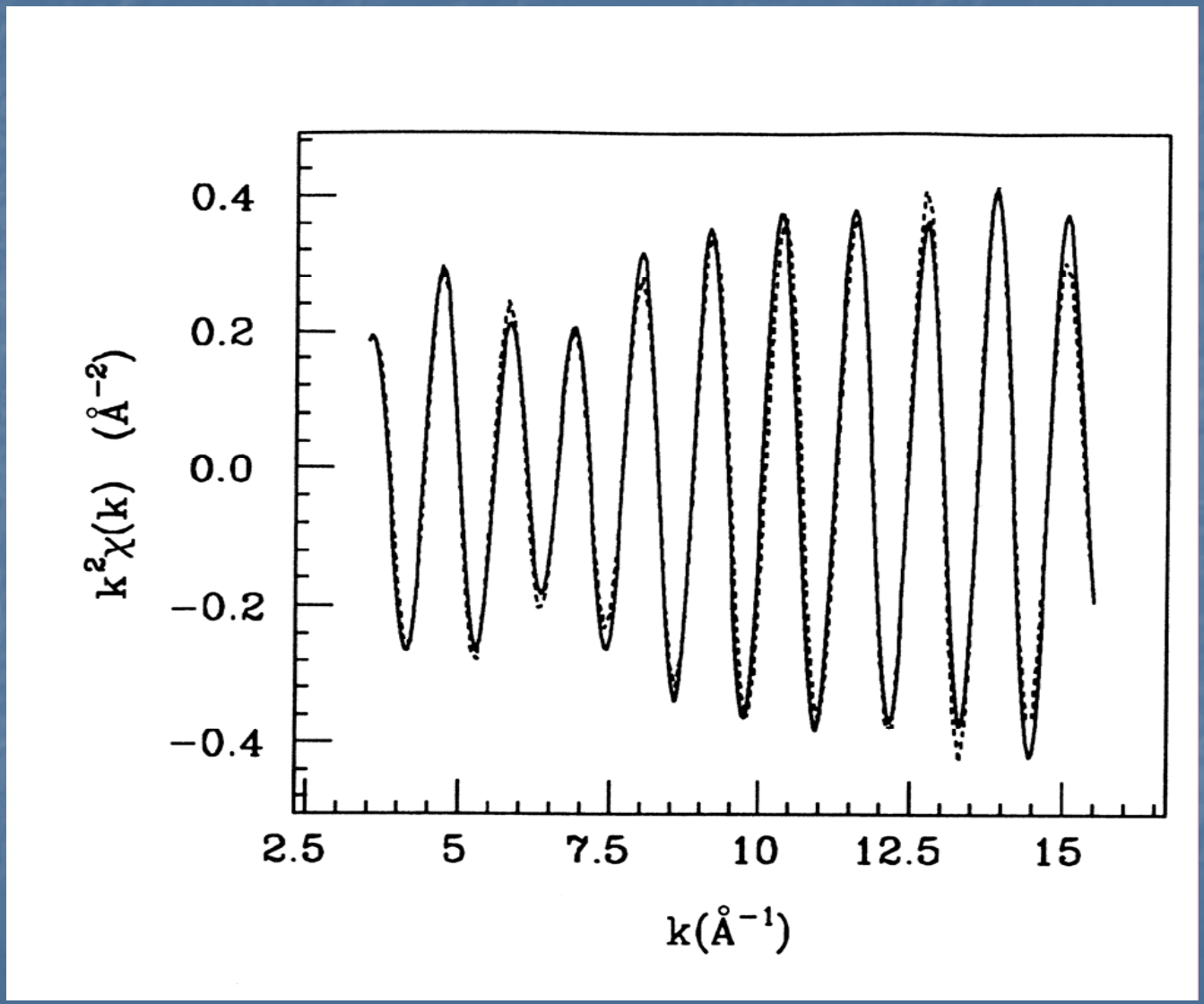
- Fourier transform of chi data

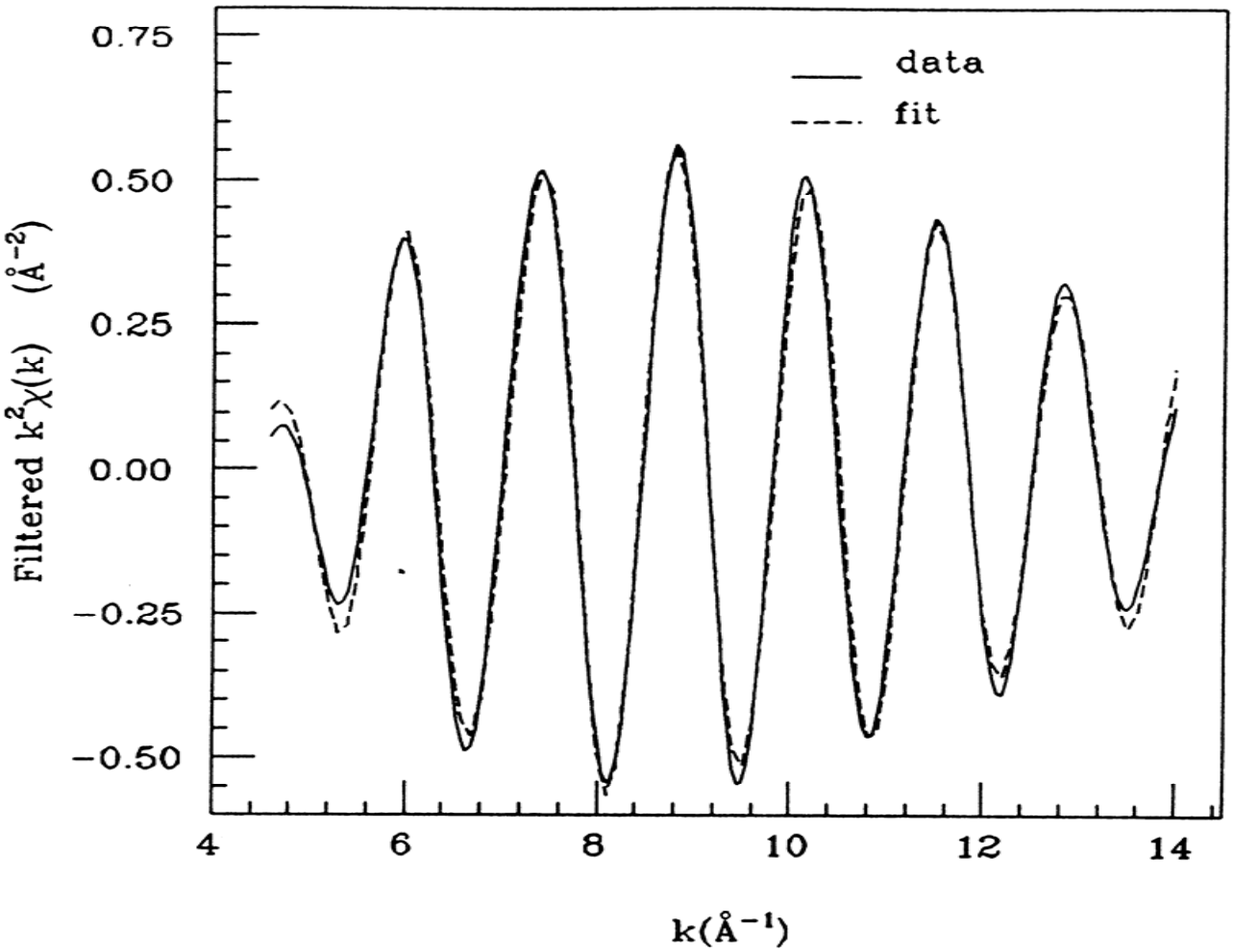


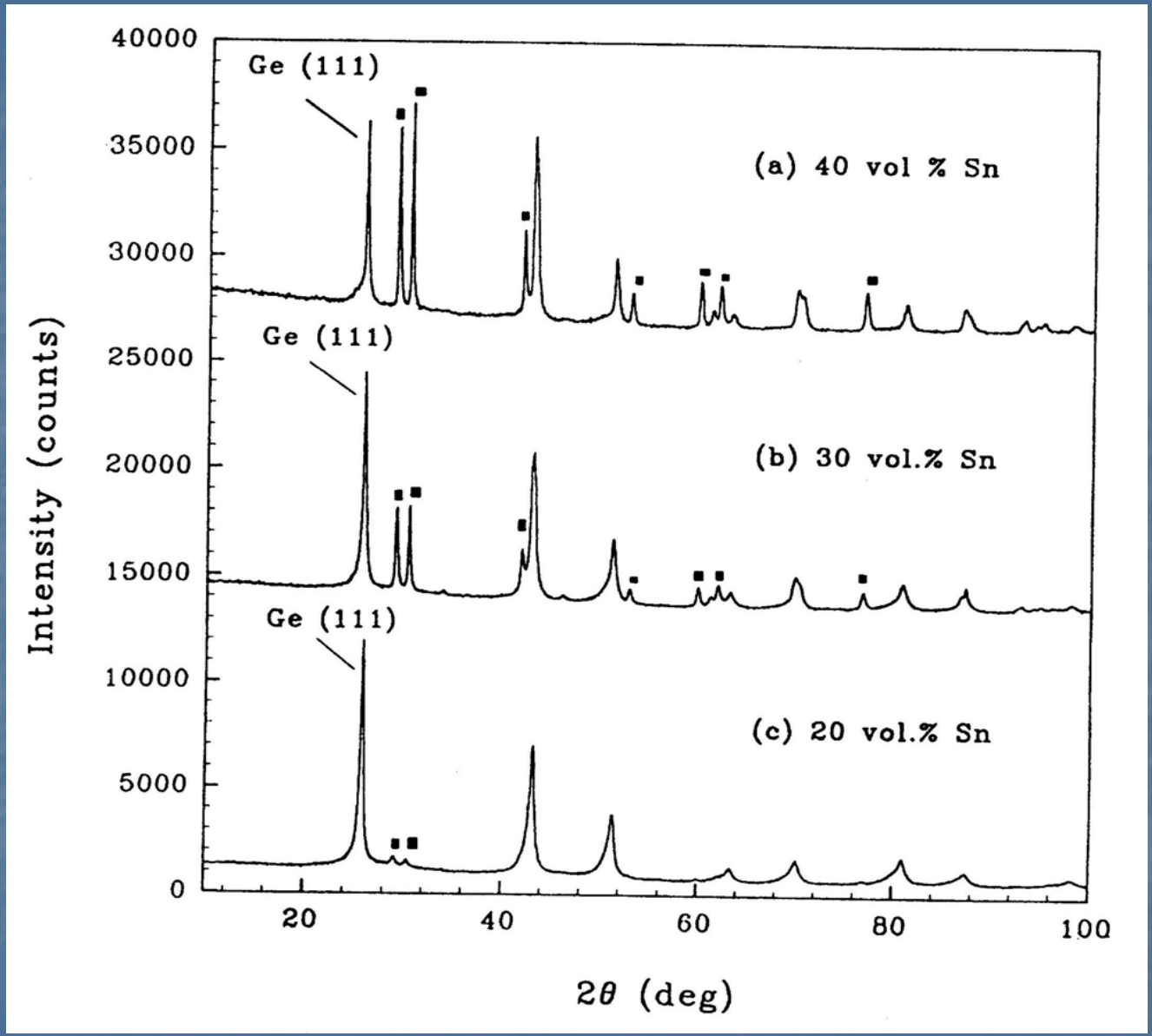

2.5
2.3
1.2
3.0
2.6
2.2
1.8
1.4
(a)
(b)
(c)
28.8
29.2
29.6
30.0
30.4
Photon Energy (keV)
0.5
0.0
-0.5
0
5
10
15
k(Å⁻¹)
Sn
40 at.% Sn
20 at.% Sn


Magnitude of Transform (Å^{-3})
0.8
0.6
0.4
0.2
0.0
P_A
(a) Sn powder
0.6
0.4
0.2
0.0
P_B
P_A
(b) 40 vol.% Sn
0.8
0.6
0.4
0.2
0.0
P_B
(c) 20 vol.% Sn
0
2
4
6
8
Radial Distance (Å)


0.4
0.2
0.0
-0.2
-0.4
(a)
0.50
0.25
0.00
-0.25
-0.50
(b)
Filtered $k^2\chi(k)$ (Å^{-2})
2.5
5
7.5
10
12.5
15
k(Å^{-1})


0.4
0.2
0.0
−0.2
−0.4
$k^2\chi(k)$ (Å^{-2})
2.5
5
7.5
10
12.5
15
k(Å^{-1})


0.75
0.50
0.25
0.00
−0.25
−0.50
Filtered $k^2\chi(k)$ (Å^{-2})
data
fit
4
6
8
10
12
14
k(Å^{-1})


Intensity (counts)
40000
35000
30000
25000
20000
15000
10000
5000
0
Ge (111)
(a) 40 vol % Sn
Ge (111)
(b) 30 vol.% Sn
Ge (111)
(c) 20 vol.% Sn
20
40
60
80
100
2θ (deg)

Results

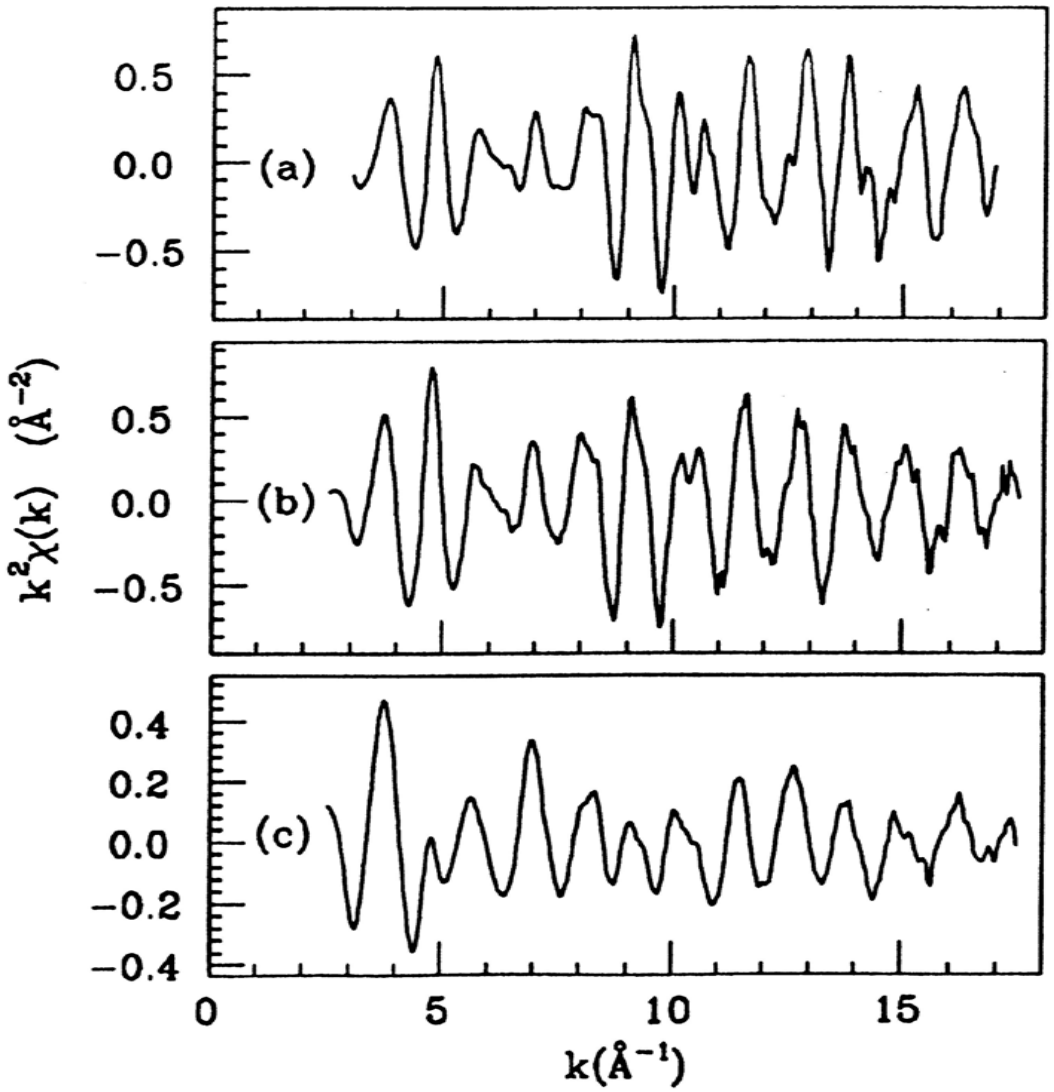
- Interfacial Sn is a few monolayers

- Einstein Temperature θ_E = 325 K

  (For metallic Sn θ_E = 325 K,

  Ge $\rightarrow$ 352 K, GaAs $\rightarrow$ 318 K

- SnGe 50/50 alloy with a = 6.15 Å


0.5
0.0
−0.5
(a)
0.5
0.0
−0.5
(b)
0.4
0.2
0.0
−0.2
−0.4
(c)
$k^2\chi(k)$ (Å^{-2})
0
5
10
15
k(Å^{-1})

Results

- Interfacial Sn ~ a monolayer
- Einstein Temperature θ_E = 351 K

Thank You