Interface Mixing in Ni_3N/SiX Bilayers Induced by Swift Heavy Ions

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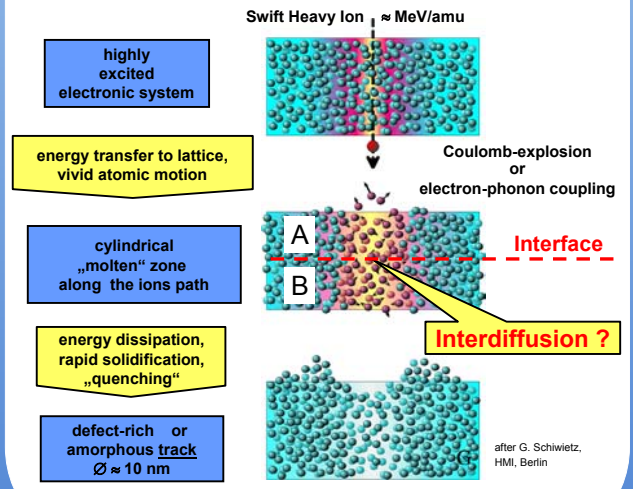
Motivation



Experiments

Au 350 MeV
Xe 230 MeV
Kr 260 MeV
Kr 140 MeV
Ar 90 MeV
T = 77K

(reactive) magnetron sputtering onto substrat

≈100 nm: Ni_3N / SiO_2; Ni_3N / SiC

≈100 nm: Ni_3N / Si_3N_4; Ni_3N / Si

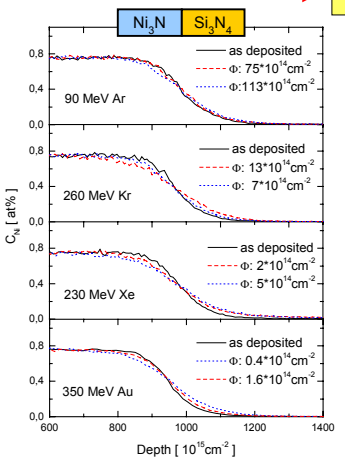
$\langle S_e \rangle$ = 6 – 39 keV/nm

Fluences: 10^{13} – 10^{16} cm^{-2}

Fluxes: 10^{10} – 10^{11} ions cm^{-2} s^{-1}

Results

RBS: He 0.9 MeV → **Concentration Profiles**



$S_e < S_{ec}$ no mixing effect

Threshold Effect S_{ec}

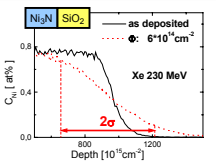
$S_e > S_{ec}$

S_e

increasing mixing effect

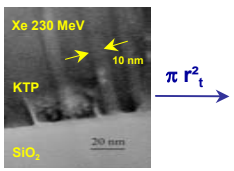
mixing rate

$k = (\sigma^2(\Phi) - \sigma^2(0)) / \Phi$



Diffusion Constant

$k = \Delta \sigma^2 / \Phi$



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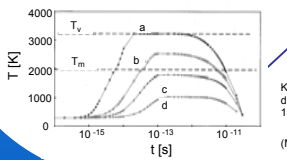
πr_t^2

Mixing effect of a single ion

2D $t_t = \Delta \sigma^2 / \Phi \pi r_t^2$

→ D : 10^{-3} - 10^{-4} cm^2/s

→ interdiffusion in liquid state

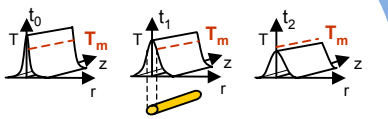


t_t : 10^{-11} s

Kr 3.4 MeV/amu in SiO_2
distance from ion path [nm]
1(a), 3(b), 4.5(c) und 8 (d)

(M. Toulemonde NIM B116(1996)37-42)

instantaneous 1-dim. energy deposition along the ion path



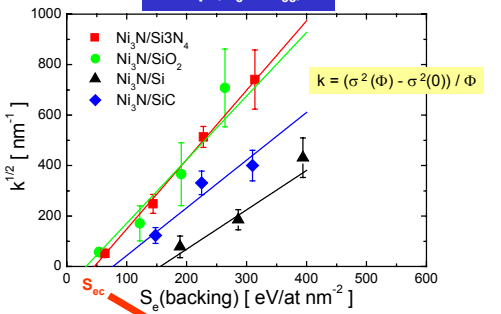
Interdiffusion in a cylindrical molten track

Ref.: W.J. Johnson, et al. , NIM B 7/8 (1985) 657

Global Thermal Spike Model $k \sim F_D^2$

developed for nuclear stopping regime, but failed

$k = \eta^2 (S_e - S_{ec})^2$



Theoretical and Experimental Thresholds