Smoothing, compaction, mixing and sputtering of semi-metal and halogenide coatings by SHI irradiation

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Motivation

Previously: Investigation of SHI induced mixing in metals, insulators and semi-conductors.

Here: Response of semi-metals and ionic materials to SHI irradiation.

Experiment

~ 100 nm

Bi Si

~ 150 nm

Bi SiO₂

T = 77 K

CaF₂ MgF₂ BaF₂ LiF SiO₂

Film evaporation at RT.

Possible effects

Coating

Surface:

Smoothing
Roughening
Sputtering

Substrate

Bulk:

Compaction
Swelling
Amorphisation

Interface:

Ion Beam Mixing
Phase formation
Phase separation

Analysis

RBS-Spectrum: Change of low energy edge of coating material.

σ [nm] = Ω [keV] / S [keV/nm]

Bismuth

Asymmetric thickness distribution
Gaussian thickness distribution
Reduction of distribution width

Few large particles
Many small particles

ONLY SMOOTHING - NO MIXING WITH SUBSTRATE
SMALL SPUTTERING, SMALL COMPACTION

Fluorides

As deposited
X+Y-scale 10µm Z-scale 500nm

Fluence 4*10¹³ cm⁻²

ª [nm] = Ω [keV] / S [keV/nm]

CaF₂

LOW FLUENCES:
SMOOTHING AND COMPACTION

CaF₂ = 1000  BaF₂ = 2500

CaF₂

Sputtering yields for 350 MeV Au:

CaF₂ = 1000  BaF₂ = 2500

Smoothing, Mixing and Dewetting are larger or faster in BaF₂ as in CaF₂ by a factor of 2.5

Effect of track radius?

CaF₂

MEDIUM FLUENCES:
INTERFACE MIXING WITH SiO₂

LOW FLUENCES:
SMOOTHING AND COMPACTION

MEDIAN FLUENCES:
INTERFACE MIXING WITH SiO₂

HIGH FLUENCES:
DEWETTING BY PLASTIC FLOW!

Smoothing, Mixing and Dewetting compete

CaF₂

BaF₂

CaF₂

BaF₂

CaF₂

BaF₂