Using Nuclear and optical methods to study irradiated multilayer structures

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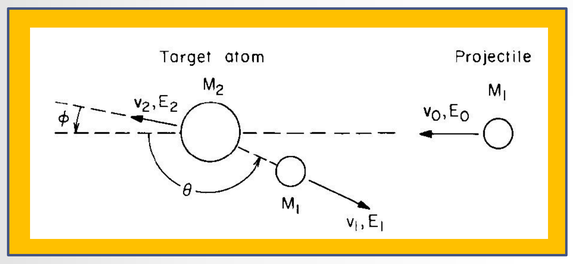
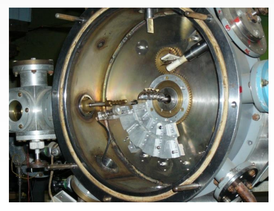
The results of research on the six-layered SiO_2 and TiO_2 systems on the Si-crystalline substrate are presented in this work.The samples SiO_2TiO_2/Si were implanted with Ne^+, Ar^+ and Kr^+ at the room temperature with the same fluence. It was $3x10^{16}$ ions/cm^2 . The energy of the all ions was 250 keV.

RBS - exp

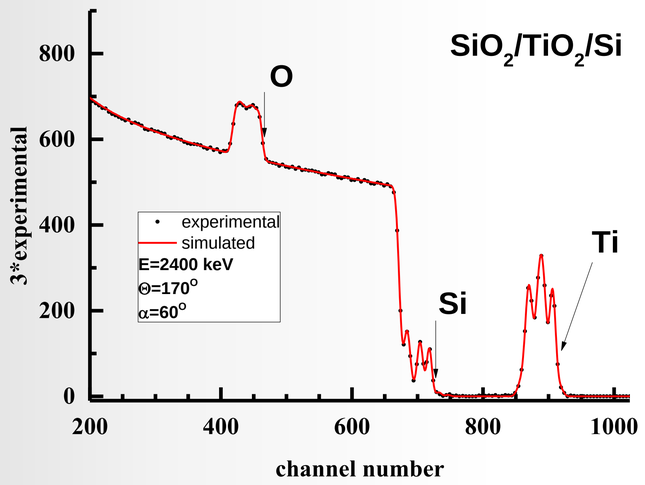


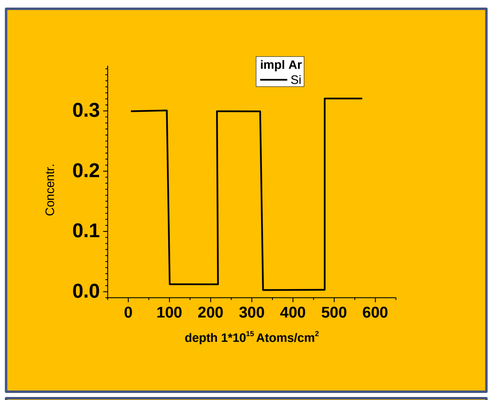
EG-5

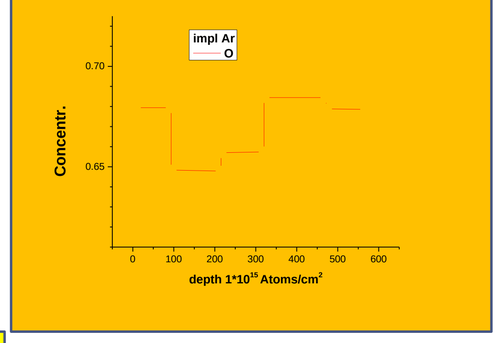


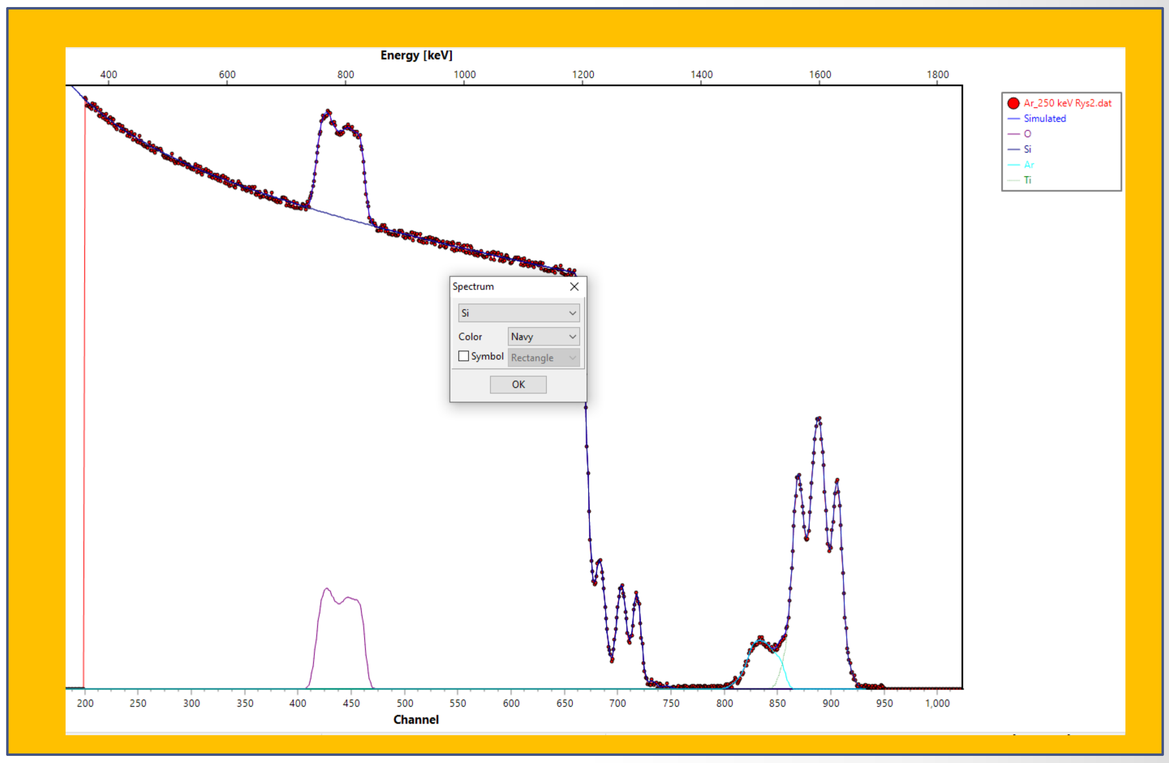
$$\frac{1}{2}M_1v_0^2 = \frac{1}{2}M_1v_1^2 + \frac{1}{2}M_2v_2^2,$$
$$M_1v_0 = M_1v_1\cos\theta + M_2v_2\cos\phi,$$
$$0 = M_1v_1\sin\theta - M_2v_2\sin\phi.$$

SIMNRA code



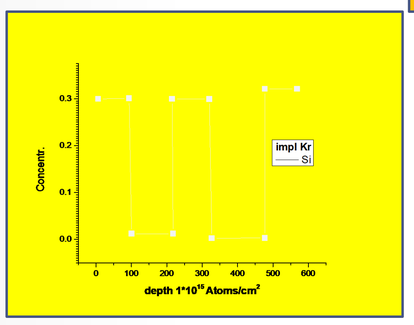






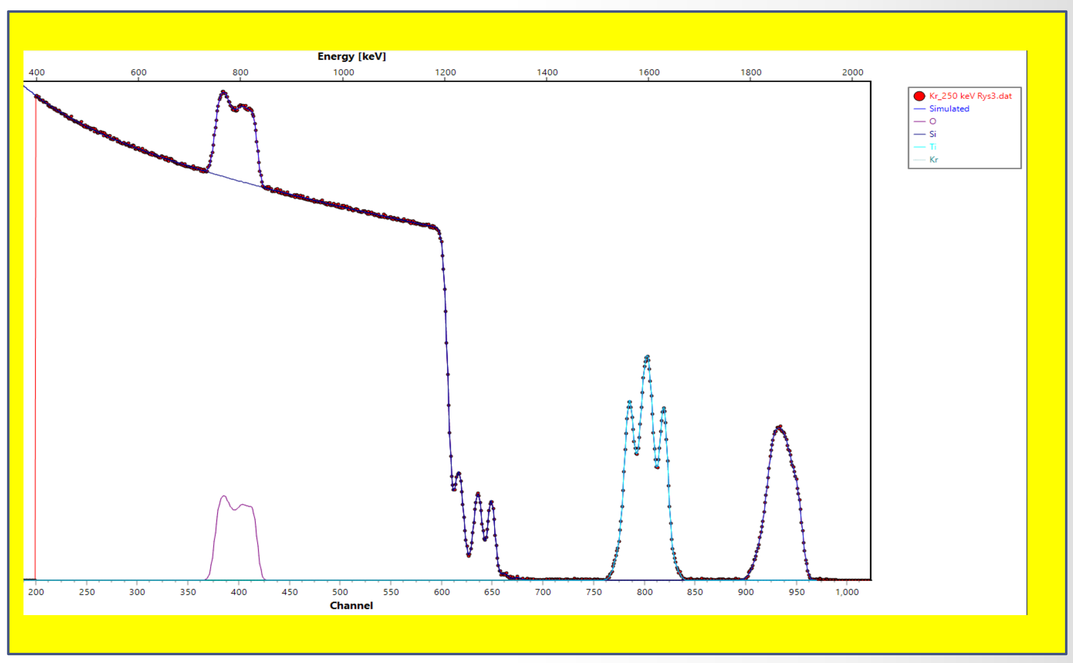
Before ion impl.

Befor Ion Impl.			
thickness layer [1x10^{15} atom/cm^2]	Si	O	Ti
96	0.33	0.67	0.00
104	0.00	0.33	0.67
116	0.33	0.67	0.00
177	0.00	0.33	0.67
117	0.33	0.67	



E=250 keV Ar^+ impl $3x10^{16}$ cm^{-2}

After Ion Implantation Ar^+			
Thickness layer [1x10^{15} atoms/cm^2]	Si	O	Ti
81	0.33	0.67	0.00
15 mix	0.30	0.60	0.10
99	0.00	0.67	0.33
14 mix	0.29	0.56	0.15
100	0.33	0.67	0.00
10 mix	0.10	0.60	0.30
167	0.00	0.67	0.00
4 mix	0.05	0.65	0.30
115	0.33	0.67	0.00



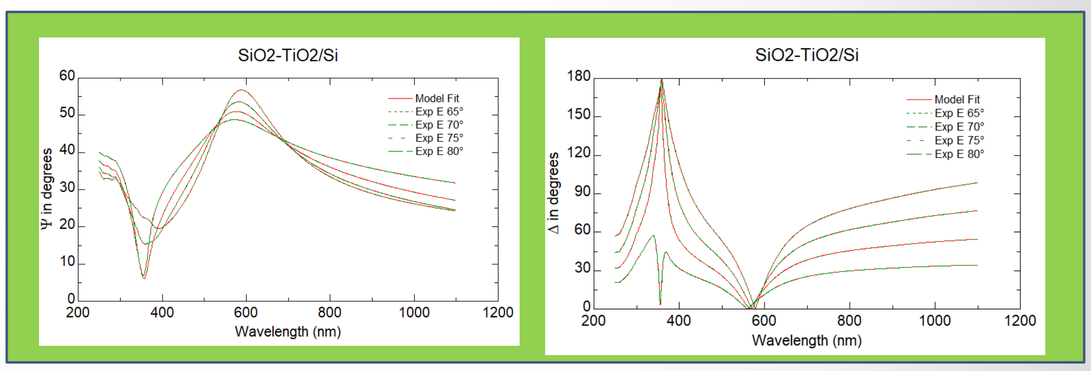
It is noted that at the interface between TiO_2 and Si layers, a transitional layer is formed in the process of ion implication. This is related to the displacement of the Ti and O atoms.

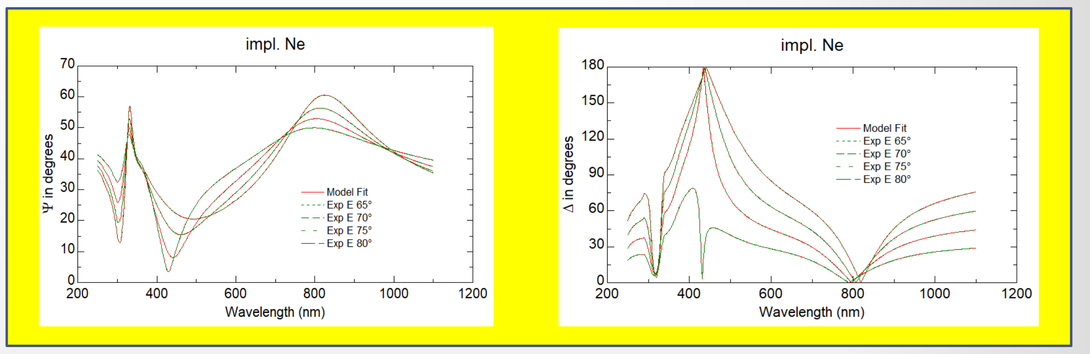
After Ion Implantation Ne^+			
Thickness layer [1x10^{15} atoms/cm^2]	Si	O	Ti
85	0.33	0.67	0.00
15 mix	0.29	0.60	0.11
100	0.00	0.67	0.33
12 mix	0.25	0.55	0.20
100	0.33	0.67	0.00
10 mix	0.20	0.59	0.31
165	0.00	0.67	0.00
7 mix	0.12	0.60	0.28
114	0.33	0.67	0.00

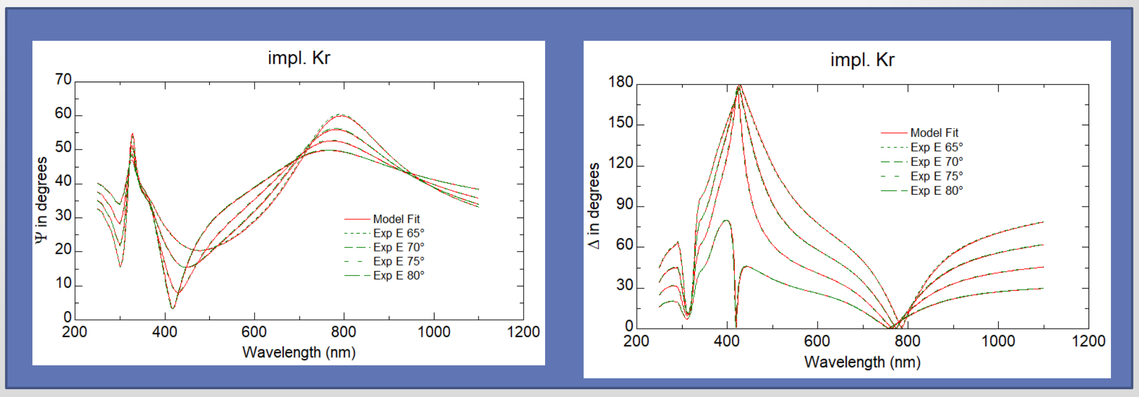
After Ion Implantation Kr^+			
Thickness layer [1x10^{15} atoms/cm^2]	Si	O	Ti
81	0.33	0.67	0.00
15 mix	0.32	0.60	0.08
99	0.00	0.67	0.33
14 mix	0.32	0.60	0.08
100	0.33	0.67	0.00
10 mix	0.09	0.60	0.31
167	0.00	0.67	0.00
2 mix	0.01	0.67	0.32
115	0.33	0.67	0.00

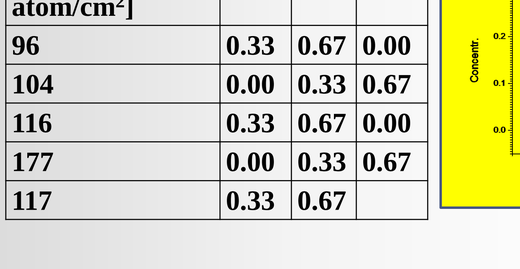
SE - exp

E=250 keV Kr^+ impl $3x10^{16}$ cm^{-2}

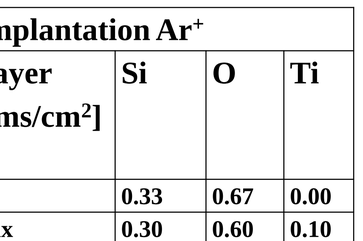




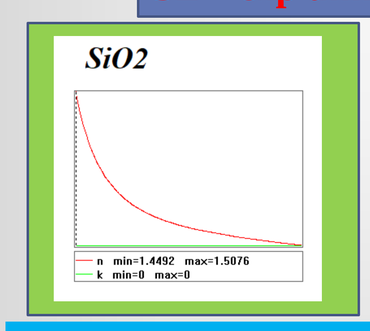


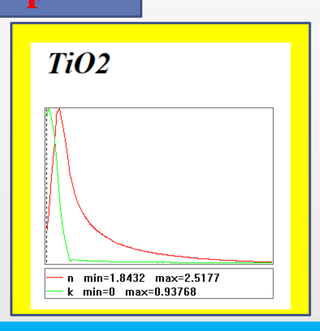


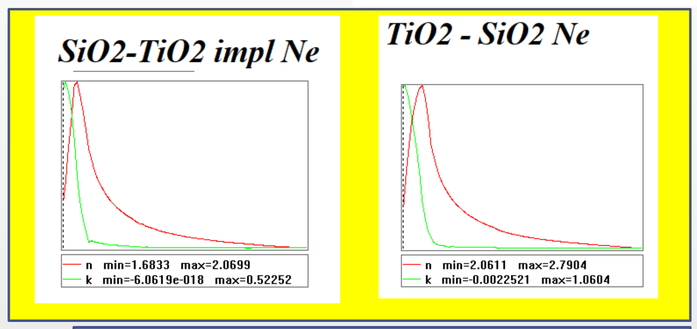
$$\frac{E_p^{out}/E_p^{in}}{E_s^{out}/E_s^{in}} = \frac{\tilde{r}_p}{\tilde{r}_s} = \frac{|r_p|}{|r_s|}e^{i(\delta_p-\delta_s)} = tg(\Psi)e^{i\Delta} = \rho$$

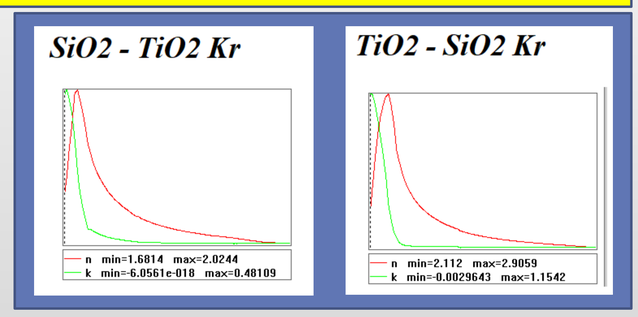


SE – exp unimpl.









The results of the ellipsometric studies have shown that as the ion mass increases, the extinction coefficient values increase faster compared to the refractive index spectra. These effects can be attributed to the formation of a homogeneous mixture of the transient layers.