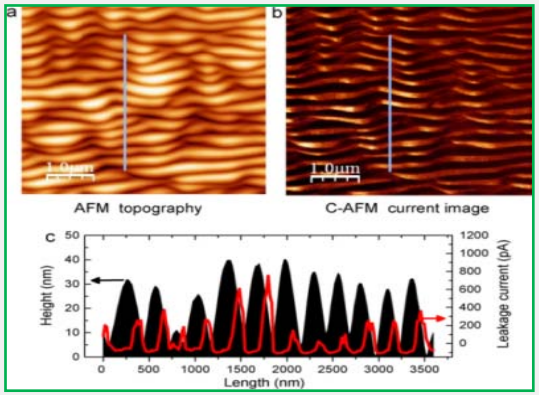
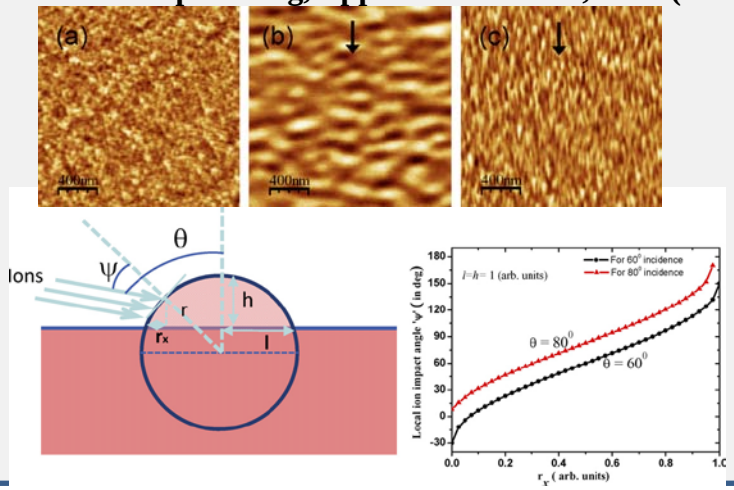
Surface science studies using ion-beams from the facility

We study Ion beam induced nano-pattern formation and coulomb sputtering on Si, Silicon oxide, Zinc Oxide, Carbon films etc. using Oxygen, Carbon, Argon, Nitrogen, Iron, Nickel ion beams from the facility.

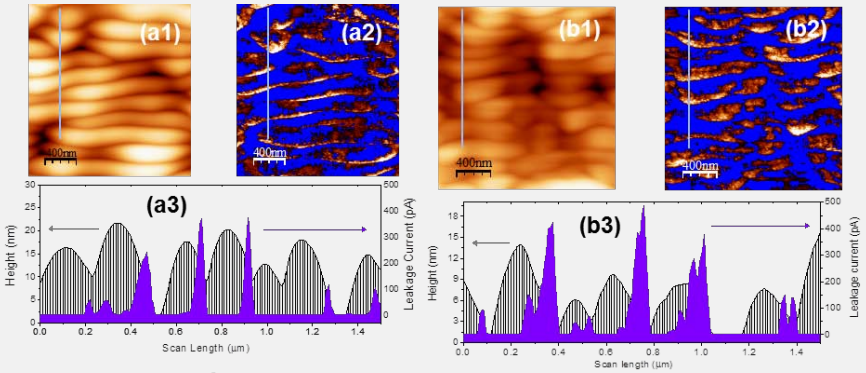
Regularly spaced conducting or magnetic stripe formation by keV ion bombardment, Appl. Surf. Sci. 258, 4125 (2012)

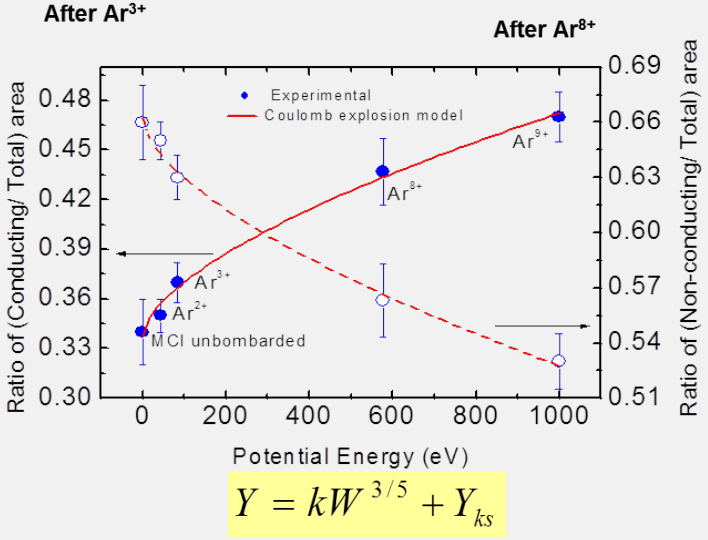


Ripple topography on thin ZnO films by grazing and oblique incidence ion sputtering, Appl. Surf. Sci. 257, 6775 (2011)



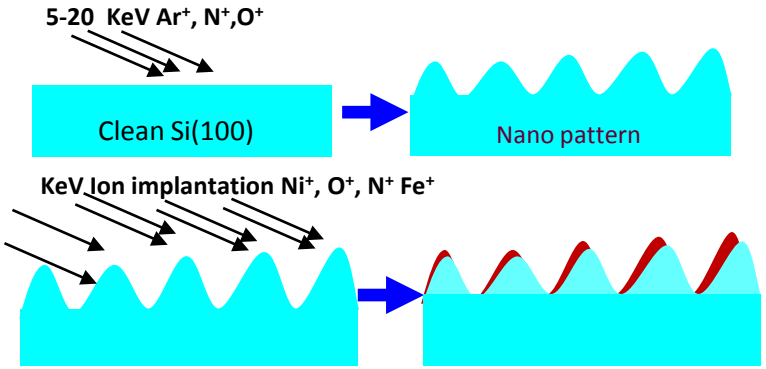
Coulomb explosion sputtering of selectively oxidized Si, J. Phys. Cond. Matt. 22, 175005 (2010).

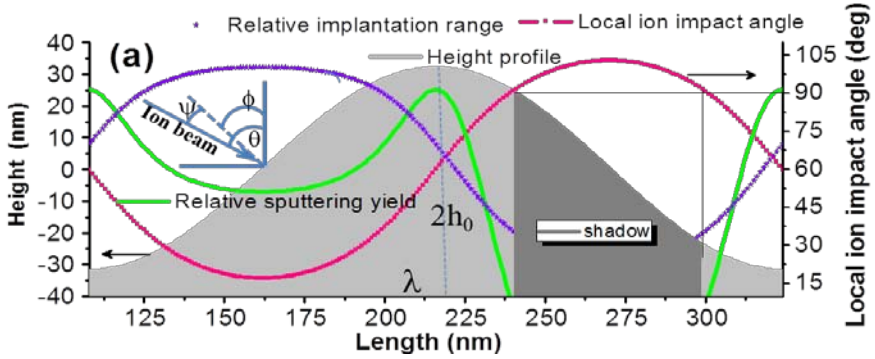




$$Y = kW^{3/5} + Y_{ks}$$

Formation of nano dot, nano wire and well structures by broad ion beam implantation on pre fabricated nano-patterns

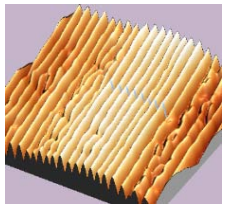




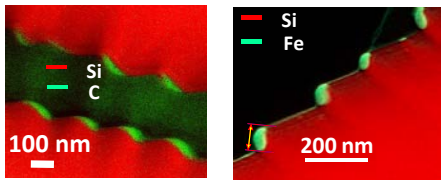
$$\alpha = \theta - \tan^{-1}\left[\frac{-2\pi h_0}{\lambda}\sin\left(\frac{2\pi x}{\lambda}\right)\right]$$

$$R = \left(\frac{\ln E_i - 1}{c}\right)\cos\theta$$

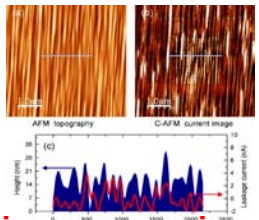
$$\frac{Y(\theta)}{Y(\theta=0)} = (\cos\theta)\exp\left(\frac{a^2\sin^2\theta}{2\alpha^2}\right)$$



Germanium ripple



Nano wire of Fe and SiC



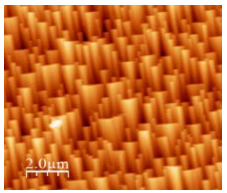
Platinum nano wires on Si

Nano wires on Si

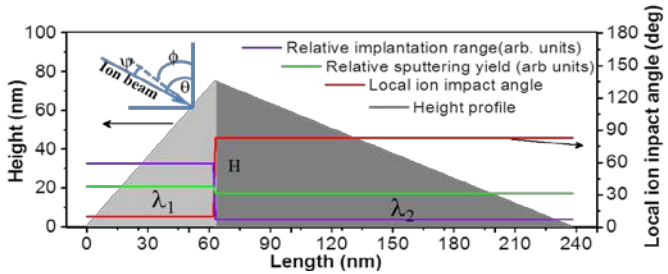
P. Karmakar, Appl. Surf. Sci. 258, 4125 (2012)

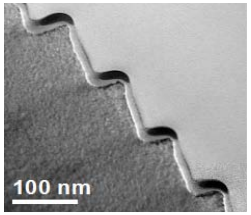
P. Karmakar et .al, Appl. Phys. Lett. 104, 231601 (2014)

P. Karmakar and B. Satpati, J. Appl. Phys. 120, 025301 (2016).



Si conical structure



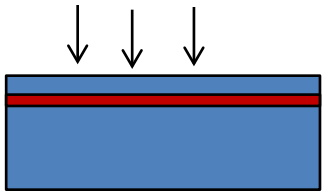


TEM Cross sec view

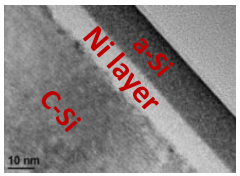
Nano dots on Si

Large area single step Ni nano dot formation

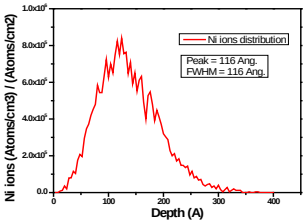
P. Karmakar et al (communicated)



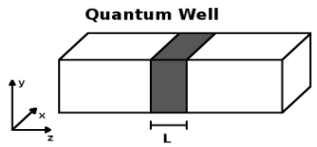
Ni buried layer by implantation



TEM Cross sec view



TRIM calculation

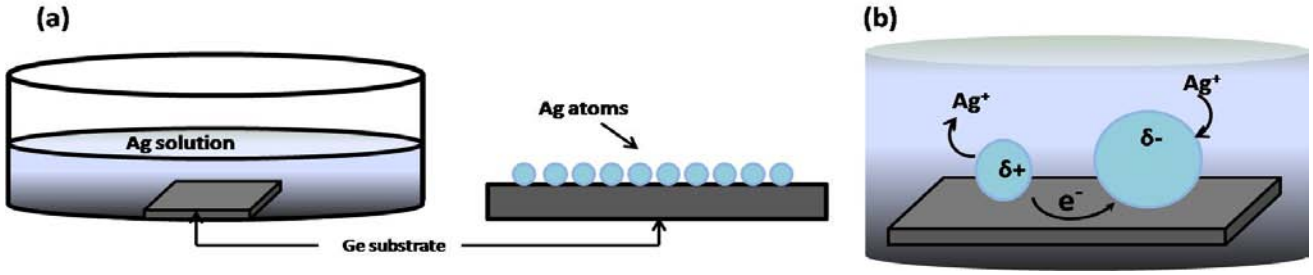


Ni buried layer in Si

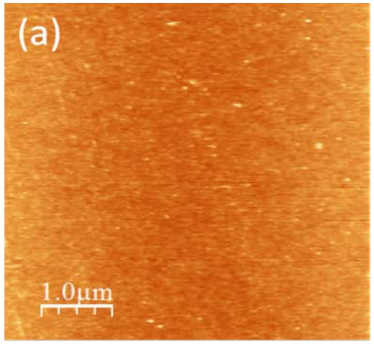
D. Bhowmik, Appl. Surf. Sci, 422, 11(2017)

Atomic Force Microscopy study of ostwald ripening of Ag nano particle on ion beam induced a-Ge surface

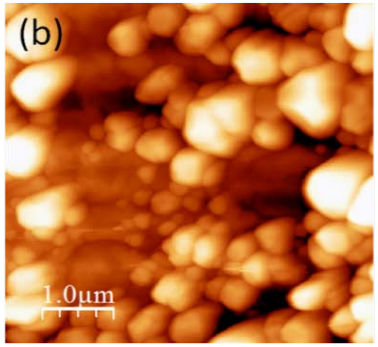
T. Ghosh, P. Karmakar and B. Satpati, **RSC Advances 5,** 94380 (2015).



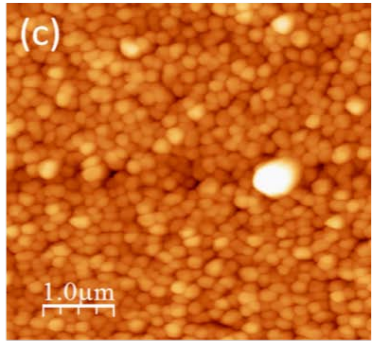
(a) Galvanic displacement process. (b) Electrochemical Ostwald ripening.



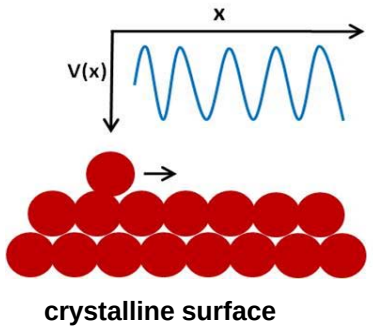
virgin Ge(100)



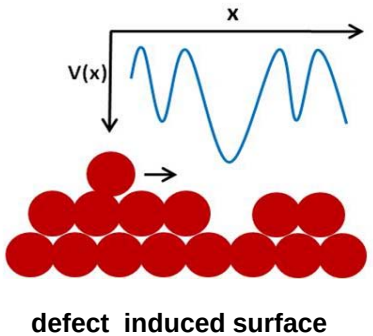
Ag nanoparticles on Ge(100)



Ag nanoparticles on O^+ ion bombarded Ge substrate



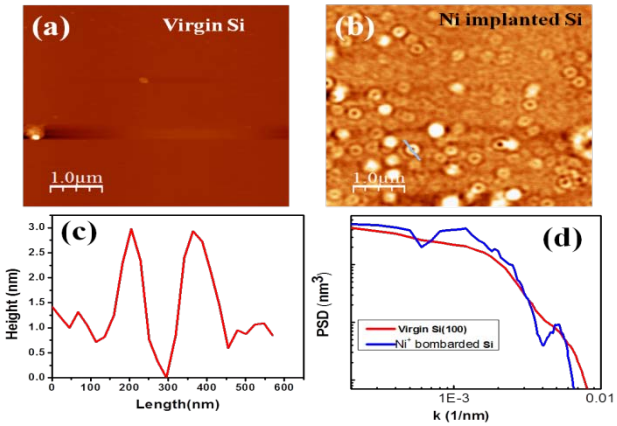
crystalline surface



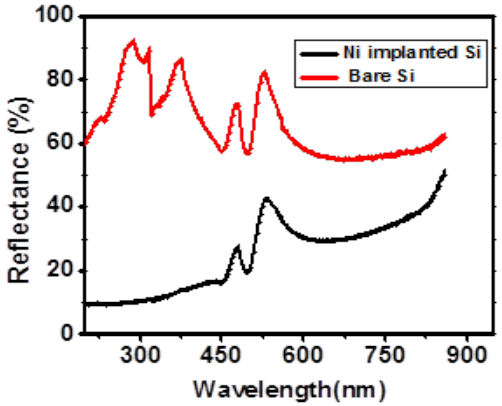
defect induced surface

Synthesis of nano-patterned and Nickel Silicide embedded amorphous Si thin layer by ion implantation for higher efficiency solar devices

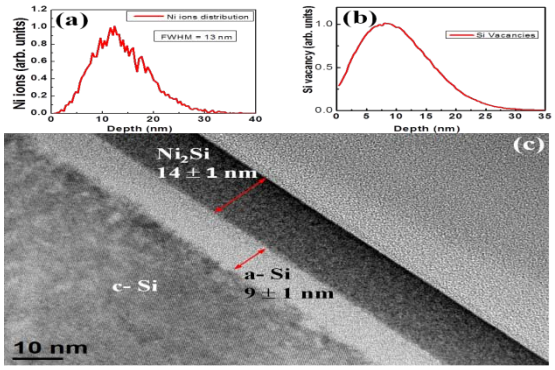
D. Bhowmik, S. Bhattacharjee, D. Lavanyakumar, V. Naik, B. Satpati, and P. Karmakar, Appl. Surf. Sci. 422, 11 (2017).



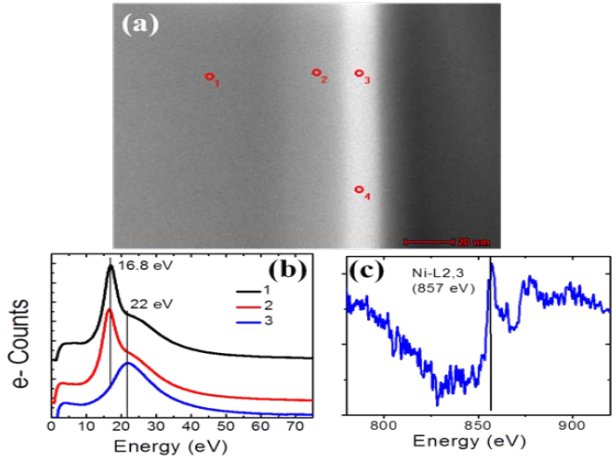
AFM topography of (a) Virgin Si(100) surface, (b) 10 keV Ni^+ (fluence 1×10^{17}) bombarded Si(100) surface showing rim surrounded crater structure, (c) line profile along the marked line on (b), (d) The Power Spectral Density profiles of the virgin and the irradiated Si.



Reflectance data showing the huge absorption of light by nanopatterned and Ni_2Si embedded a-Si compared to bare Si.



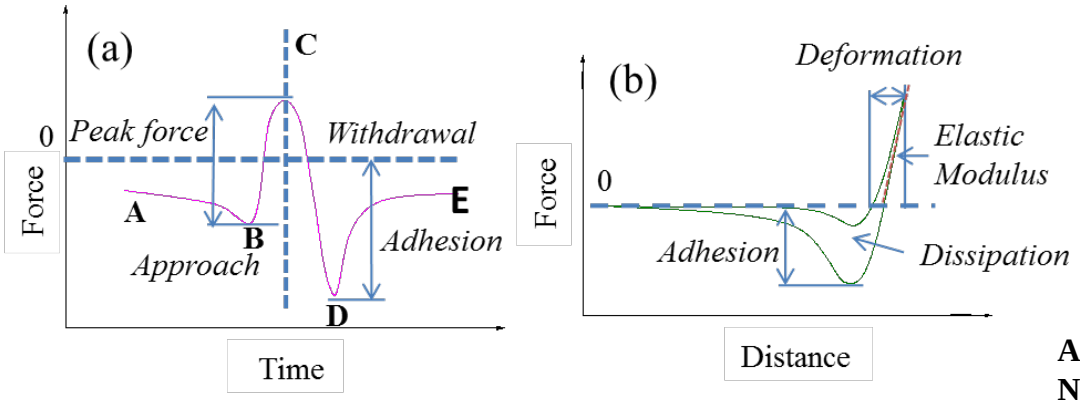
(a) implanted Ni atoms and, (b) Si vacancy due to 10 keV Ni ion bombardment on Si at normal incidence; (c) Cross-sectional TEM view of 10 keV Ni^+ ion implanted Si(100).



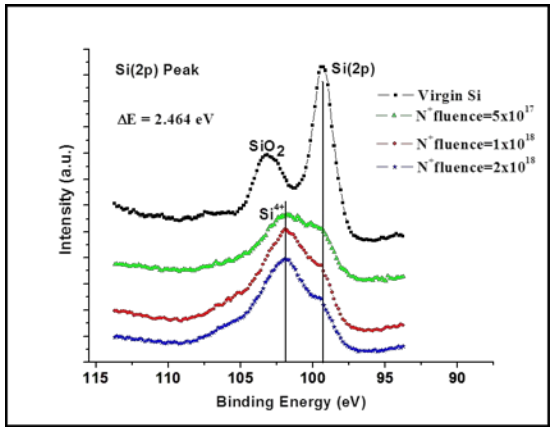
Cross-sectional STEM-HAADF and EELS spectra showing Nickel silicide formation during 10 keV Ni^+ ion bombardment on Si (a) Cross sectional STEM-HAADF image for ion fluence of 1×10^{17} ions/cm^2, (b) Low- loss spectra at t positions 1, 2 ,3 of (a) , (c) Core-loss spectra at Ni-L2,3-edge at position 4 of (a).

Nano mechanical property of ion induced Si ripple patterns

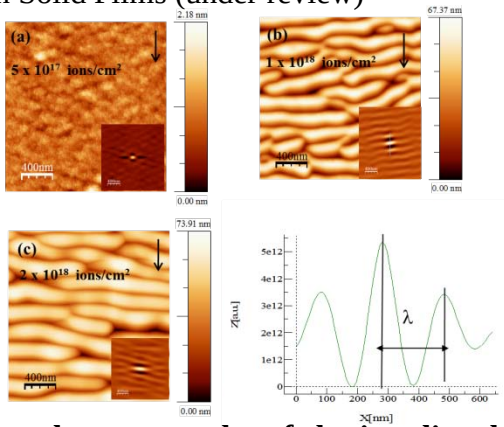
S. Bhattacharjee, D. Lavanyakumar, V. Naik, S. Mondal, S. R. Bhattacharyya and P. Karmakar, Thin Solid Films (under review)



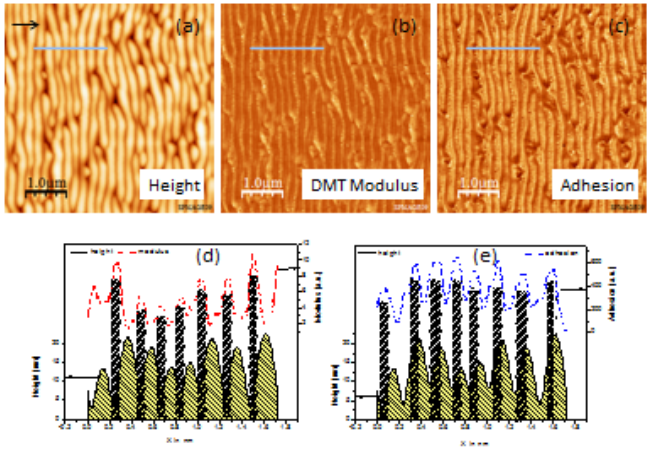
(a) Force-time representation, showing the principle of peak force operation of the AFM. (b)showing different peak force channels.



X ray photoelectron spectroscopy data showing the shift of Si(2p) peak towards the higher binding energy for N^+ ion implanted rippled Si surfaces at ion fluences 5×10^{17}, 1×10^{18} and 2×10^{18} ions/cm^2 compared to virgin Si surface. The shifted does not change with ion fluence but peak intensity decreases with Nitrogen fluence. The change of oxidation state of Si due to Nitrogen implantation indicates the Silicon Nitride formation.



AFM image showing the topography of the irradiated sample with N^+ ions at a fluence of (a) 5×10^{17} ions/cm^2, (b) 1×10^{18} ions/cm^2 and (c) 2×10^{18} ions/cm^2 .(d) Shows the 1D-autocorrelation function along the wave vector of the ripple structure



Peak force QNM data of the irradiated samples at a fluence of 2×10^{18} ions/cm^2. Images of (a) height, (b) elastic modulus and (c) adhesion of the nitrogen ion induced rippled surface.(d) and (e) shows the height (in lower panel) with modulus (in upper panel)and height (in lower panel) with adhesion (in upper panel)profile respectively along the line on (a), (b) and (c).Periodic variations of modulus and adhesion are clearly observed.