Seminar

Institute for Plasma Research

Title : Nanoscale functionalization of ion-beam fabricated ripples and facets

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Time : 03:30 PM

Venue : Online - Join the talk:
https://meet.ipr.res.in/Dr.MaheshSaini_PDFTalk

Abstract :

Ion-beam induced pattern formation has proven its efficiency in single step fabrication of a gamut of patterns with size-tunability by manipulating ion-beam parameters on various substrates including semiconductors, metals, and insulators. This talk studies the use of 500 eV Ar ion-beam sputtering (top-down approach) for fabrication of self-organized silicon nanostructures where the achieved self-organization of nanostructures is a special feature of ion-beams. Further to this, bottom-up approach is used to functionalize silicon nanopatterned substrates by decorating them with gold nanoparticles (Au-NPs) and sputter-grown conformal zinc tin oxide (ZTO) films for viable technological applications. For instance, Au-NP arrays on rippled (R)-Si exhibit enormous near-field enhancement between Au-NPs leading to surface-enhanced Raman scattering (SERS)-based detection of an ultralow concentration (10 μM) of crystal violet dye. Thus, Au-NP arrays on R-Si work as an efficient and longevous surface-enhanced Raman scattering (SERS) sensor due to the prolonged stability of Au in environmental conditions for detection of complex molecules having low Raman scattering cross-sections. In another report, cold cathode electron emission is observed from Au-NP-decorated ensembles of self-organized silicon nanofacets (Si-NFs) having fascinating ultralow turn-on field (as low as 0.27 V μm^{-1}) and remarkably low threshold electric field (as low as 0.37 V μm^{-1}) with outstanding stability. It is interesting to note that even as-prepared Si-NFs offer hitherto unseen low turn-on field (as low as 0.58 V μm^{-1}) and threshold field (0.66 V μm^{-1}) – so far Si-based nanostructures are concerned. Kelvin probe force microscopy studies reveal that tunability in work function of Au-NP-decorated Si-NF samples depending on dimension and growth-angle of Au-NPs. In addition, in-depth dual pass tunnelling current microscopy measurements demonstrate that Au-NPs on apexes and sidewalls of Si-NFs act as cold cathode electron emission sites which help to improve the turn-on and threshold fields for Au-NP-decorated Si-NFs in comparison to their as-prepared counterparts where electron emission takes place mostly from their sidewalls and valleys. This study paves the pathway to fabricate self-organized Si nanostructure-based highly stable cold cathode electron emitting devices having fascinating low turn-on and threshold fields along with extremely high field enhancement factors for use in nanoscale electronic devices. On the other hand, broadband antireflection is observed from ZTO coated pristine-, R-, and NF-Si substrates due to distractive interference and graded refractive index of the heterostructures which is useful in efficient ZTO-based optoelectronic devices and heterojunction solar cell applications.