Topical Session-9: Nanocharacterization and metrology

9P-001
Adsorption of lysine on phosphate-protected magnetite nanoparticles in water solution
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Keywords: magnetite(Fe3O4), nanoparticles, adsorption, phosphate, lysine.
Abstract: Understanding the interaction between magnetic nanoparticles with biomolecules is crucial for their biomedical usage including magnetic separation, magnetic drug delivery and MRI imaging. Fe3O4 nanoparticles with size and surface chemistry uniformity provide a good platform for studying biomolecule adsorption. We prepared such particles by combining thermal decomposition synthesis in organic phase with ligand exchange and phase transfer into water. As an example, we studied the adsorption of lysine on phosphate-protected Fe3O4 nanoparticles in aqueous environment. The nanoparticles-lysine conjugates were characterized in terms of size and zeta potential by dynamic light scattering (DLS). Surface composition was analyzed by Fourier transform infrared (FTIR) spectroscopy and X-ray photoelectron spectroscopy (XPS), respectively. Detailed interaction scheme is given and it is postulated that the bonding involves electrostatic attraction (NH3+--O-P), hydrogen bonding (NH2…O-P) and chemical bond (C-O-Fe) on the surface and through secondary adsorption.

9P-002
A simple colorimetric method for the quantification of gold nanoparticles in aqueous and fetal bovine serum solutions
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Keywords: gold nanoparticles, quantification, spectroscopy assay, fetal bovine serum
Abstract: In this work, we developed a facile and low-cost method with sufficient sensitivity for the quantitative determination of gold nanoparticles (GNPs) in aqueous and serum solutions. The Au(III) digested from GNP was reduced to Au(I) by thiol group of MBI, then Au(I)-thiolate complex was formed, which is determined by absorbance at 300 nm. The interference of serum can be avoided in this method. The limit of detection (LOD) of gold ions was calculated as 0.1771 μM in aqueous solution and 1.1212 μM in fetal bovine serum (FBS) solution. The number concentration of GNP can be converted using microscopic images and simple calculations. This method provides a simple and fast way to determine concentration of gold nanoparticles, which can be in operated in the routine laboratory practice and avoid complex operations.

9P-003
Influence of lift up height in EFM DC mode
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Keywords: EFM, Electrical property of CNT, Lift-up height of probe, Phase response
Abstract: As rare SWCNT materials contain both metallic CNT (m-CNT) and semi-conduct CNT (s-CNT), which have different applications in nano electric device, it is very important to separate metallic CNT from semiconductor for more efficient CNT utilization and improving the performance of the device. In the past few years, scholars have proposed many methods, such as DEP separation method, chemical reaction removal method, centrifugation separation method and so on, but the reliability and accuracy of these methods need to be measured, thus it is very important to differentiate m-CNT and s-CNT, which will contribute greatly to choose suitable separating method and adjust suitable parameters in CNT preparation. Scientists proposed a method to judge CNT’s electrical property based on DC Electric Force Microscope (EFM) mode only by the scan line type ‘V’ or ‘W’. But we discovered there is a key shortcoming in this method, which is that the lift-up height will greatly affect the scan line type and thus makes this method not reliable in distinguishing m-CNT from s-CNT. The authors have deeply researched the influence of lift-up height on the scan line to improve the method of detecting the electricity of CNT. We found that during scanning CNT, the phase response comes from the force acted on the tip both by the...
CNT and the substrate. During scanning CNT at a small lift-up height, there is negative phase due to attractive force acted on the tip by CNT, and this negative phase is larger than the positive phase caused by the substrate, thus the scan line is “V” type. But as lift-up height increases, the attractive force applied on probe by CNT reduces, thus the absolute value of the negative phase decreases, although the positive phase caused by substrate also reduces, but its reduction rate is less than the negative phase, which makes the scan line on CNT protrude and change the shape of scan line from “V” type to “W” type. The results show that CNT’s response to the probe resonance phase under EFM mode is largely depended on the probe lift-up height.

9P-004
A series of two-dimensional covalent organic frameworks synthesized by Schiff-base couplings on highly oriented pyrolytic graphite (HOPG) surface
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Keywords: aromatic aldehyde; aromatic amines; Schiff-base; covalent organic framework; bilayer; scanning tunneling microscopy
Abstract: The bottom-up methodologies for preparing long-range highly ordered robust nano-architectures on single crystal surfaces is a key challenge for nanotechnology. In the present work, we perform co-condensation reactions between aromatic aldehyde and aromatic amine monomers on highly oriented pyrolytic graphite (HOPG) surface. We extend simple and moderate methodologies for preparing surface confined 2D covalent organic frameworks (COFs) with little defects and almost entire surface coverage. The simplest method to fabricate 2D COF in our study is mixing Benzene-1, 3, 5-tricarboxaldehyde and p-Phenylenediamine at octanoic acid/HOPG interface at room temperature. Additionally, based on the co-condensation of Benzene-1, 3, 5-tricarboxaldehyde and different length of aromatic amines, a series of 2D Schiﬀ-base COFs with diﬀerent pore dimensions at gas/solid interface were obtained after a simple thermal treatment in vacuum conditions. The corresponding isoreticular pore sizes were from ~1.9 to 3.6 nm. By using this simple way we obtained one 2D COF at liquid/HOPG interface and three 2D COFs with tunable pore size at gas/HOPG interface based on Schiff-base couplings. The 2D COF synthesized by Benzene-1, 3, 5-tricarboxaldehyde and p-Phenylenediamine was reported in crystalline solid material [3]. However, its 2D analogue by on-surface chemistry has never been reported. The other two of the 2D COFs are new materials that have not been reported even in the field of bulk crystals. Besides the synthesis of well-ordered 2D COFs on HOPG surface, the formation of bilayer COFs was found. The first and the second layer are stacked in an eclipsed manner which is similar as bulk COF structure. It provides direct evidence to confirm the stacking structure of bulk COF at the molecular level. The covalent interlinked frameworks on the HOPG substrate were characterized by scanning tunneling microscopy (STM) under ambient conditions.

9P-005
Numerical study of the lateral resolution in electrostatic force microscopy for high resolution imaging in ambient
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Keywords: Electrostatic force microscopy, lateral resolution, finite element method.
Abstract: Electrostatic force microscopy (EFM) including its derivative, Kelvin probe force microscopy, is widely used to investigate mesoscopic/nanoscopic conducting/semiconducting structures and electrical interactions. The experimentally achieved lateral resolution of EFM in ambient, which is typical tens of nanometer, is largely limited by applicable force-detection techniques, including the modulation mode, the tip-sample separation, and the probe geometry and diameter. For different tip-sample separations and tip geometries, Y. X. Shen et al have simulated the lateral resolution of EFM using boundary element method and calculated the force component and force gradient component that would be employed by amplitude modulation EFM (AM-EFM) and frequency modulation EFM (FM-EFM), respectively. C. Riedel et al have numerically studied the lateral resolution of EFM for dielectric samples. However, the realization of sub-10 nm resolution for ambient EFM is still challenging in experiment and equivocal in theory.
Employing a bimetallic sample with surface potential inhomogeneities as the special case, here we systematically simulate the lateral resolutions of EFM using the boundary element method. The lateral resolutions of EFM are calculated respectively for tip-sample separation range from sub-nanometer to one hundred nanometer, for AM-EFM and FM-EFM respectively, and for various geometries and diameter of the probe including a tip, a cone and a cantilever. Different from the common viewpoint in the literature, our simulation results suggest that for a relatively small tip-sample separation, ambient EFM may achieve a lateral resolution of a few nanometers, which is as superior to that in vacuum. Optimal