Bioorganic Nanodots Memory Storage Devices

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Bioinspired nanoscale building blocks that are self-assembled from proteins and peptides, became an object of intensive research, due to integration feasibility of this new generation of bio-nanomaterials in diverse nanotechnological applications. These nanostructures exhibit exceptional physical properties[1] such as one of the strongest measured piezoelectric signal among biological structures [2], pronounced non-linear optical response [3]. They are used for efficient carbon electrode coating of supercapacitor electrodes [4], and demonstrate unique visible photoluminescent properties.[5]

Here we focus on a new class of nanodots of biological origin (Figure) self-assembled from chemically synthesized peptide biomolecules [6]. In this work peptide nanodots (PND) are composed from diphenylalanine (FF) biomolecules which are a core motif of Alzheimer beta amyloid polypeptide. We show that PND are stable organic dielectric nanocrystals of homogenous size, ~ 2nm size with energy gap ~4.0-5.0 eV possessing very low conductivity 10^{-13} $Sm \cdot cm^{-1}$. Transmission electron microscopy (TEM) of isolated PND shows that PND are molecular crystal particles that was also confirmed by the Fourier transform images displaying discrete diffraction spots, indicates the single crystalline structure. Mass- and secondary ion mass-spectrometry suggested that the PND is composed from a dimer of diphenylalanine molecules used in these work.

We employed these bioorganic nanounits for charge storage using PND arrays of high density and studied the ability of the PND monolayer to retain charge by using Kelvin Probe Force Microscopy (KPFM). We study their electron/hole trapping mechanisms at the nanoscale, and charge retention ability followed by fabrication of PND embedded into metal-oxide-semiconductor memory cell devices as charge storage nanoparticles for non-volatile memory [7].

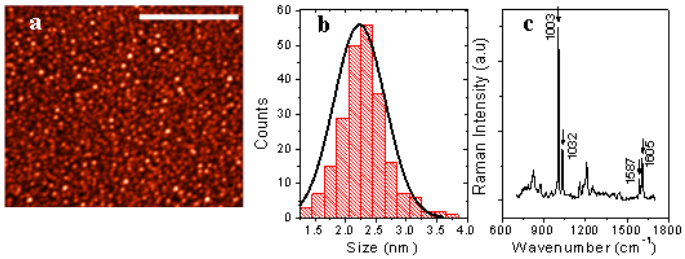

Figure: AFM morphology of the FF PND**.** (a) FF PND on Si surface. (b) Size-distribution histogram of (a). (c) Raman spectrum of (a) using a Raman NSOM apparatus.

References

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