Trends in Applied Sciences Research

ISSN 1819-3579

Academic
Journals Inc.

www.academicjournals.com

Trends in Applied Sciences Research 6 (2): 204-207, 2011
ISSN 1819-3579 / DOI: 10.3923/tasr.2011.204.207

Case Study on Construction of Platinum Nanoparticle Stabilized with Decanethiol into Silica Substrate

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ABSTRACT

In current study, it was reported the investigational manner to manage the construction of 80 nm, organically capped, platinum (Pt) nanoparticles by means of variation the deposition conditions. Two dissimilar deposition techniques were used to assess the authority of the NP solution volume. By means of drop casting technique, much liquid was worked, resulting in a ventilation time of about 100 sec, whereas the piezodropper system create tiny drops, in such a way that the solvent evaporates in few seconds and NPs do not have adequate time to aggregate in wider area. A improved control on the location of NPs on the substrates can be attained by means of the piezodropper system, which facilitates the assembly of hundreds of nanometers wide 2D area.

Key words: Pt, deposition, SiO_2, nanostructured area

INTRODUCTION

The aptitude to manage the spatial display of nanocrystals is of basic significance for the fabrication of nanoscale plans. It is broadly documented that self-assembly is an successful bottom-up plan to build nano devices from molecular nanopatterns (Parviz *et al*., 2003). In this framework, thiol-stabilized nanoparticles are good-looking as useful materials for many uses, as their chattels can be adjusted by an alert selection of shape, material, size, environment and temperature (Love *et al*., 2005). Thiol legends offer a appropriate channeling distance between the nano particles, therefore making them good-looking nanomaterials to examine fresh quantum transport phenomena in restricted systems (Daniel and Astruc, 2004). In this viewpoint, regular and controlled (Iwata *et al*., 2007) assembly of NPs is of basic significance because of addresses the experimental circumstances to tempt a self organized enlargement of regular 2D Platinum NP structures, with no any chemical adjustment of the substrate. Platinum NPs of 80 nm diameter, functionalized with Decanethiol, were employed. It was used diverse self-assembly deposition procedures to revision if the shape and the size of spatial NP arrangements can be tuned by chemical circumstances with the purpose of make possible their utilization in quantum nanostructures.

MATERIALS AND METHODS

Platinum NPs, prepared from British Biocell Intl. and functionalized with Decanethiol and dissolved in toluene, along with the modus operandi designate by Weiss *et al*. (2006). Depositions were chiefly carried out onto silicon dioxide (SiO_2). With aspire of integrate NP systems with functional materials, such as transition metal oxides, which have rich physical belongings and with the final objective to viaduct electrode gaps and to create a device. Two dissimilar deposition

techniques was used to assess the authority of the NP solution volume: the drop casting technique allowed to discharge 8 mL volume drops of NP solution, at the same time a piezodropper system delivers much smaller drops (tenths of picoliters). The drop casting method is an easy method to bring drops of liquid in the micromolar to millimolar variety. The drops are deposited mostly by means of micropipettes onto solid surfaces. This method was applied in order to find the optimal concentration to induce two-dimensional (2D) NP structures, by unreliable the NP concentration, which was step-lowered from 2.5×10^{10} Nps mL^{-1} down to 2.5×10^{8} Nps mL^{-1}. The piezoelectric droplet dispenser consists of a glass capillary embedded in a piezoceramic tube, fixed in a holding device (Macis *et al*., 2007). Applying a voltage pulse to the piezoceramic tube, the tube and the capillary are contracted, enabling the droplet ejection. The piezodropper system was employed to better control the positioning of the NP domains, with the final objective of placing NPs between an electrode couples.

Depositions by means of the piezodropper dispenser were execute at a even NP concentration of 2.5×10^{10} Nps mL^{-1}, even as voltage scale and pulse period were mottled, in order to find the correct circumstances for the edifice of best superiority NP assemblies. Their range was selected from the calibration data provided by the manufacturer, representative the delivering of a 72 mm size drop under the submission of a voltage pulse amplitude of 63.8 V and 94 m sec pulse period. Deposition parameters were examined using two different trials: in the first one, the pulse duration was set at 200 m sec and the voltage scale was varied in the range of 70-100 V, with 5 V steps; in the second one, the voltage scale was held in reserve constant at 85 V and the pulse period was varied in the 100-500 m sec range. more than a few samples for each set of parameters were examined; the consequences showed a high degree of reproducibility in all cases. Characterization of the NP assemblies was performed by Transmission Electron Microscopy (TEM) and Scanning Electron Microscopy (SEM).

RESULTS AND DISCUSSION

The victorious overcoating Decanethiol functionalization of Platinum NPs was established by the effortlessness of precipitate solubility in toluene (in the case of not capped, the precipitate would not redissolve). At Fig. 1, it was showed a distinctive TEM image of the functionalized NPs, which have a diameter of around 80 nm. At Fig. 2, it was showed an SEM image of a NP assemblage, attained by means of drop casting. With a solution concentration of 2.5×10^{9} Nps mL^{-1}, a monolayer region more than 1.1 mm-wide shaped. Alike consequences were attained for all samples experimented, on Silica substrates. Evaporation of the drops took place in a few minutes. Concentration theaters significant position in aggregation of NPs. By inferior the solution concentration, it was observed a transform in NP assembling from three-dimensional (3D) aggregates for 2.5×10^{10} Nps mL^{-1} up to even 1.1 mm wide monolayers for 2.5×10^{9} Nps mL^{-1}, to small islet shaped by one or a only some NPs for a concentration of 4×10^{8} Nps mL^{-1} and, lastly, 3D facial appearance again for 2.5×10^{8} Nps mL^{-1}. As contrasted to the drop casting technique, much smaller and better located, drops can be transport by using the piezodropper system. Evicted drops are tenths of picoliters, with resulting much smaller evaporation time, the disparity of voltage scale and pulse period alters the array of NPs on the substrate surface. Depositions carried out at constant pulse period of 200 msec, with raising the voltage scale from 70 V, brought to the chief construction of 3D structures, awaiting the values of 85 and 90 V were reached; in these circumstances NPs be inclined to aggregate in single-layer domains. Further than these values, NPs be inclined to aggregate in three dimensions again. When the pulse period was greater than before, custody the

voltage scale at 85 V, it was observed a reduce in area size: for 100 and 200 m sec, it was obtained about 500 nm wide area, even as for bigger ethics it was only founded a few NP aggregates. Figure 3 shows the SEM picture of a distinctive monolayer attained by means of the piezodropper system; most islands were sited in usual 2D area, at what time a 90 V voltage scale and 200 msec pulse period were applied. The piezodropper system, planned with the accurate parameters, provided much smaller 2D area than those acquired by drop casting. In meticulous, the majority of the observed areas were islands no more than 400 nm wide. This consequence can be give details in terms of NP performance: NPs have sufficient mobility to move crossways the surface only in attendance of liquid, i.e., toluene; the whole quantity of liquid radically changes (6 orders of magnitude), whilst drama depositions with the two different methods. By means of drop casting, much liquid was worked, resulting in a ventilation time of about 100 sec, whereas the piezodropper

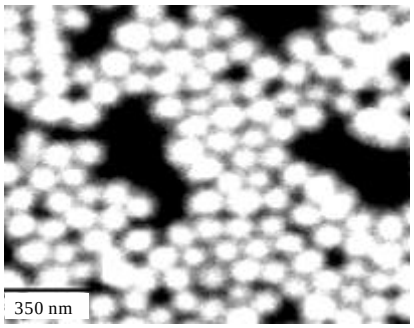

Fig. 1: TEM picture of decanethiol-functionalized Pt NPs

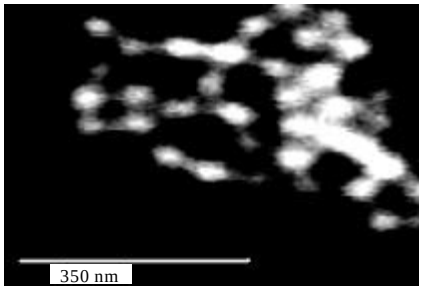

Fig. 2: SEM picture of an NP monolayer fabricated by drop casting at the concentration of 2.5×10^{9} Nps mL^{-1}

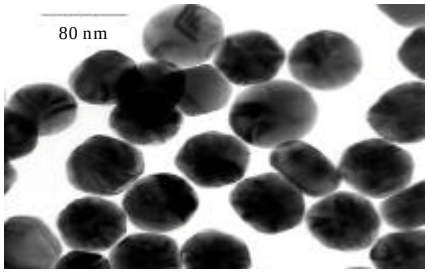

Fig. 3: SEM picture of an NP 2D area; NPs were deposited by means of the piezodropper system at the concentration of 2.5×10^{8} Nps mL^{-1}

system create tiny drops, in such a way that the solvent evaporates in few seconds and NPs do not have sufficient time to aggregate in wider area, even obtaining 2D structures.

CONCLUSIONS

It was studied the aggregation property of 80 nm Platinum NPs, stabilized with Decanethiol, from side to side two unlike deposition methods. By using the drop casting system, an NP concentration which allowed obtaining more than 1 mm-wide 2D areas was found. A improved control on the location of NPs on the substrates can be attained by means of the piezodropper system, which facilitates the assembly of hundreds of nanometers wide 2D area. The likelihood of change the length of NP area unlocks the way to their utilization as money-making quantum nanostructures among electrodes pairs, practical to achieve quantum transport studies.

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