Nanomanufacturing Science and Technology Focus Topic
Room: Central Hall - Session NM-TuP

Topics in Nanomanufacturing Poster Session

NM-TuP1 Fabrication and Characterization of Nanoscale Carbon Nanotube Patterns on Nanostructured Aluminum Surfaces, ***Y. Watanabe***, *H. Kato, S. Asami, S. Sato, S. Takemura, K. Shimada, T. Hiramatsu*, Kanto Gakuin University, Japan

The aim of the present work is to develop the nanofabrication methods of highly-oriented patterns of carbon nanotubes on the various substrates and is to characterize the electronic and optical properties of the patterns. The authors proposed a nanoscale arrangement method using a nanostructured surfaces as a nanofabrication template. Single-walled carbon nanotubes (SWCNTs) were arranged in highly-oriented line pattern with nanoscale trenches fabricated on an aluminum surfaces by combined process of chemical treatments and anodization. SWCNTs dissolved in catechin containing solution. Then this solution were dropped on the nanostructures as a droplet utilizing micropipette and extended on the surface. SWCNTs were locally aligned along the line patterns. Dynamic force microscopy (DFM) observations and the cross section analysis were conducted on pre-aligned and aligned surfaces on the highly-oriented structures. Atomic force microscopy-current imaging tunneling spectroscopy (AFM-CITS) measurements were also conducted in order to investigate local conductive properties of CNTs. In the measurement of I-V characteristics by point contact, quantum conductivity of carbon nanotubes were observed. The proposed method can be applied for the CNT arrangement on different surfaces such as Si and glass substrates by nanoscale imprint which enables the prefabricated nanoscale pattern transcription. Nano-contact transcription was performed according to the following steps: CNTs dissolved in catechin containing solution were dropped with a micropipette on an aluminum line structure. The Al sample was placed on a silicon substrate and was pressed for 30 sec in order to transfer the CNTs pattern to the Si substrate. Then the Al template was removed and the Si substrate was dried naturally. In the case of the line pattern template, it was found that SWCNTs line pattern could be transferred to a Si wafer. Transcription of double wall carbon nanotubes (DWCNTs) was also the same result. Arrangement of multi-walled carbon nanotube (MWCNT) and cup-stacking CNT was also performed. Raman characterization of the fabricated patterns of SWCNT, DWCNT, MWCNT and cup-stacking CNT was conducted in order to investigate the detailed structures on the surface. Two types of Raman peaks which were characteristic of CNT were observed by Raman measurements. Several RBM peaks appeared in the low frequency region (80-400 cm-1). Asymmetric shaped G-band was confirmed (1500-1700 cm-1). A shoulder peak was observed in the low wavenumber side of the G-band.

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NM-TuP2 Topographical and Raman Studies of Nano-graphite Patterns on Nanostructured Al and Si Surfaces by Carbon Drawing, ***Y. Takarai***, *T. Hirakawa, K. Doi, H. Kato, A. Ishii, Y. Watanabe, S. Takemura, T. Hiramatsu*, Kanto Gakuin University, Japan

The authors performed carbon drawing and embossing methods in order to fabricate nanoscale structures on nanostructured Al surface and Si wafer. Carbon drawing is a nanofabrication method by gently pushing bulk graphite on the surface and drawing it. In the present study, the authors used HOPG and black carbon flakes for carbon drawing which performed on a nanostructured Al substrate. The surfaces were investigated by scanning probe microscopy (SPM) and Raman spectroscopy. The authors performed carbon drawing on the aluminum linked-crater structure. The AFM image demonstrated that each nanoscale crater was filled with carbon by the drawing and a unique carbon dots structure was created on the surface. A unique nanostructure was also fabricated by carbon drawing on the aluminum linked-crater structure. In the case of Si wafer, drawing with carbon flakes made stripe structure. The stripe separation was approximately 1 micrometer. Raman spectroscopy was used to characterize pre-drawing Si wafer and post-drawing Si wafer. Raman peaks due to Si were observed at around 500cm-^{1} and 1000cm^{-1}in the pre-drawing sample. Some characteristic peaks of carbon were observed in the post-drawing sample. A peak at 1360cm^{-1} can be assigned to D band. A peak at 1600cm^{-1} can be assigned to G band (Graphite band). Raman peaks due to glassy carbon appeared after carbon drawing on Si wafer. Furthermore, the authors performed embossing method with inserting carbon flakes between Si wafer and nanostructured Al. It was found that unique nanostructures were created on the Si surface by embossing method. In the case of aluminum highly-oriented line structure, the embossing made the nanoscale line pattern transfer to the Si wafer. The transferred line separation was estimated as several tens of nanometers.In the case of aluminum line structure, drawing a line perpendicular to the HOPG made arch-like structure. It was confirmed that the carbon was along the line in this structure. Raman spectroscopy was used to characterize pre-drawing and post-drawing nanostructured Al surfaces. A peak due to Al_2O_3 was observed at around 2900cm^{-1} in the Pre-drawing. Some characteristic peaks were observed in the post-drawing sample. A peak at 1360cm^{-1} can be assigned to D band due to defects in the crystal which is supposed to appear when crystallinity of thin graphene is distorted. A peak at 1600cm^{-1} can be assigned to G band, which appears when the measured object is allotrope of carbon. This peak intensity depends on wavelength of incident light. This work was aided by MEXT-supported Program for the Strategic Research Foundation at Private Universities.

NM-TuP3 Photoluminescence Enhancement of Aluminum Surfaces with Various Shaped Nanostructures Filled with Metallopfthalocyanines and Organic Dye Molecules, ***A. Ishii***, *T. Shimizu, H. Kato, T. Kamino, S. Takemura, T. Hiramatsu*, Kanto Gakuin University, Japan

Nanostructures such as linked-crater and highly-oriented pillared structures made of anodized aluminum oxide were fabricated on an Al surface by combination process of chemical and electrochemical treatments. Crater–shaped structures were initially created on the alumnum surface by the chemical surface treatment. Successive anodization condition created the different sized linked-crater structures. A highly-oriented pillared structure was fabricated on an Al surface by chemical and electrochemical multi-process. Based on the initial structure fabricated by chemical surface treatments, successive anodization proceeded in the fabrication of well-ordered characteristic nanoscale patterns with highly-oriented aligned trenches on Al surface such as a groove-pattern structure. Successive surface treatment using Semi Clean assisted in fabrication of ordered finer nanoscale structures such as highly-oriented pillared structure. The present work also intended to make an organic nanoscale pattern using highly-oriented pillared structure as a template by filling of dye molecules, namely, rhodamine B (RB), brilliant green (BG) dissolved in acetonitrile, copper phthalocyanine (CuPc), iron phthalocyanine (FePc) and Cobalt phthalocyanine (CoPc) dissolved in toluene in order to functionalize the surfaces. The cross section analysis demonstrated that the dye molecules were filling the trenches along the linked-crater structure and the highly-oriented pillared structure by dynamic force microscopy (DFM) measurement. Photoluminescence measurements showed that RB emission peaks appeared in the wavelength range of 600-640 nm. In the case of BG emission peaks appeared in the wavelength range of 450-500 nm. In the case of metal phthalocyanines, CuPc, FePc and CoPc, the emission peaks appeared in the wavelength range of 450-550 nm. The authors confirmed that the significant emission enhancement happened to dye molecules filling linked-crater and highly-oriented pillared structures fabricated on the aluminum surface. The structure of RB filling aluminum nano-structures were investigated by FT-IR measurements. It was found that the intensity of Al-O mode at 800-1000 cm^{-1} in the case of highly-oriented pillared structure was larger than that in the case of the linked-crater structure while the intensity of Al-O mode at 1000 cm^{-1} was comparable between two structures. It was also found that the emission peaks appeared in the wavelength range of 1200-1700 cm^{-1} in both cases of linked-crater and highly-oriented pillared structures. This work was aided by MEXT-supported Program for the Strategic Research Foundation at Private Universities.

Authors Index

Bold page numbers indicate the presenter