CdTe/HgTe/CdTe구조 나노입자의 광전류 특성

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Photocurrent Characteristic of CdTe/HgTe/CdTe Structured Nanoparticles

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Abstract : The photocurrent characteristics of CdTe/HgTe/CdTe structured nanoparticles are studied. CdTe/HgTe/CdTe multilayer structured nanoparticles were synthesized by colloidal method. CdTe/HgTe/CdTe multilayer structured nanoparticles were characterized by x-ray diffraction, high-resolution transmission electron microscopy(HRTEM), absorbance and photoluminescence(PL). PL spectrum of CdTe/HgTe/CdTe multilayer structured nanoparticles exhibits a strong exciton bond in the near infrared range. The I-V curves and photoresponses revealed that CdTe/HgTe/CdTe multilayer structured nanoparticles are very prospective materials for the photodetectors

Key Words : Photocurrent, CdTe/HgTe/CdTe, Nanoparticle

1. Introduction

Recently semiconductor nanoparticles have been exten-sively studied, and especially Ⅲ-Ⅴand Ⅱ-Ⅵ semiconduc-tors have been interested materials in the field of optoelec-tronics operating in the range from visible to infrared wave-length region.[1-3] For example, HgTe and Ⅱ-Ⅵ core-shell nanoparticles exhibit near infrared luminescence from 900 to over 1800nm with extremely high quantum efficiency, which can apply to optical telecommunication windows.[4,5]

In this paper, the photocurrent characteristics of CdTe/HgTe/CdTe structured nanoparticles are studied. CdTe/HgTe/CdTe multilayer structured nanoparticles were synthesized by colloidal method. CdTe/HgTe/CdTe multi-layer structured nanoparticles were characterized by x-ray diffraction, high-resolution transmission electron micros-copy(HRTEM), absorbance and photoluminescence(PL).

2. Experimental Method

The synthesis for CdTe/HgTe/CdTe multilayer struc-tured nanoparticles were prepared in CdTe nanoparticles 10ml as precursors by colloidal method. and then a 10ml of CdTe nanoparticles dispersed water was diluted to 100ml, and Hg(ClO4)2•6H2O and 42㎕ of 1-thioglycerol was added subsequently to the solution and the solution pH was adjusted to ~11.6 with 1M NaOH. The solution was then purged with nitrogen for 30min. And then under stirring, H_2Te gas which was generated by the reaction of 0.084 g of Al_2Te_3 and 10 ml of 0.5 M H_2SO_4 under N_2 atmosphere was passed through the solution together with a N_2 flow for 20 min.

A solid film was fabricated by dropping nanoparticles on a patterned ITO substrate. And aluminum was evapo-rated as metal contacts on the top of this nanoparticle film. The excitation sources for PL and photocurrent were the 325-nm wavelength light from a He-Cd laser and the 633-nm wavelength light from a He-Ne laser. A Keithley 237 source-measure-unit was used to measure I-V curves and the photocurrent. All the measurements were per-formed under vacuum.

3. Results and discussion

Figure 1 shows XRD pattern of CdTe/HgTe/CdTe nanoparticles prepared by colloidal method. The broaden-ing of the XRD peaks observed in the XRD pattern origi-nates from the nanometer-scaled diminution of the crystal-lite sizes.

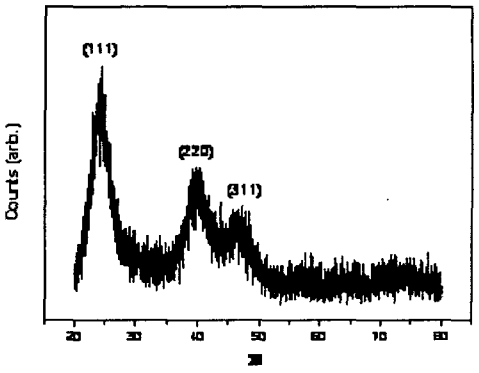

Fig.1 XRD pattern of CdTe/HgTe/CdTe nanoparticles.

The size of nanoparticles is measured to be about 5nm dimeter and very high crystalline in HRTEM image. Their size is larger compared with CdTe nanopartigle size (about 2~3nm) from the HRTEM image of the nanoparti-cles shown in Fig.2.

The normalized PL spectra of CdTe, CdTe/HgTe/CdTe and HgTe in solution are compared in Fig.3. We observed

that the absorption and PL spectra are shifted to the longer wavelength and the exciton bond width of the CdTe/HgTe/CdTe nanoparticles is broader than that of CdTe nanoparticles.

Figure 4 shows *I-V* curves in the dark and under illumination (325-nm light or 633-nm wavelength light). The difference of *I-V* curves in the dark and under the illumination is responsible for the charge carriers excited by the above and below gap light. The asymmetric shape of *I-V* curves may be caused due to the difference of work function

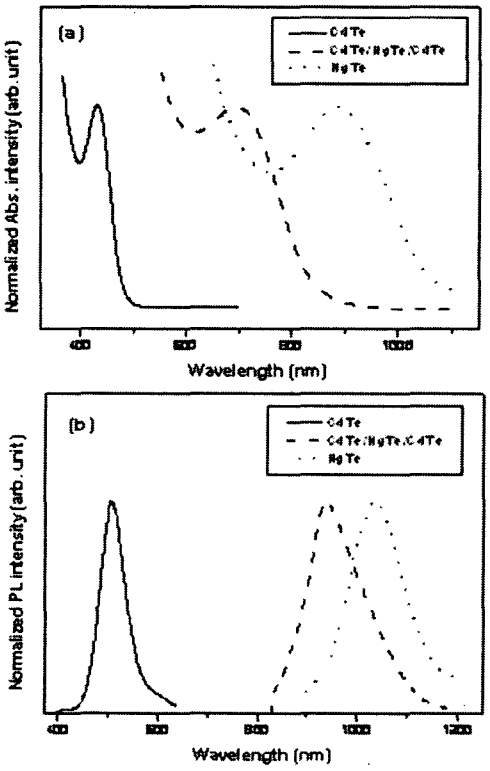

Fig.3 Absorption and PL spectra of the CdTe (solid line), CdTe/HgTe/CdTe (dash line) and HgTe (dot line) nanoparticles.

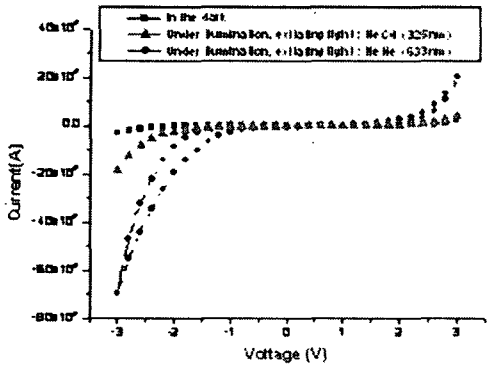

Fig.4 The current-voltage (*I-V*) curves for the CdTe/HgTe/CdTe nanoparticle film in the dark and under the illumination

Figure 5 shows the time-dependent photoresponse of the film at an applied voltage of -3V under 633-nm wavelength light from He-Ne laser. When the light is on and off, the current rises slowly and decays due to the trapping and detrapping processes of photo-generated electrons.

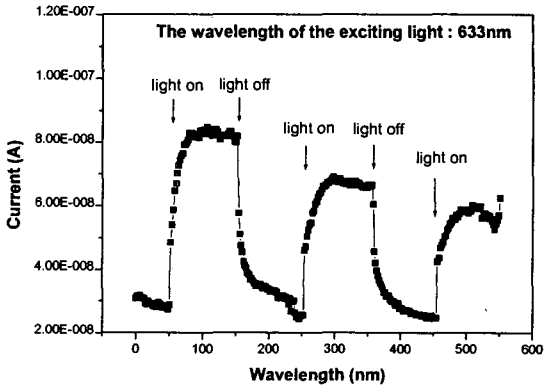

Fig.5 The photoresponse of the film as a function of time depending on an applied voltage of -3V

4. Conclusion

We synthesized CdTe/HgTe/CdTe multilayer structured nanoparticles by the colloidal method. PL peak position of nanoparticles is red-shifted by 400 nm compared with CdTe nanoparticles. The photocurrent characteristics of CdTe/HgTe/CdTe multilayer structured nanoparticles are confirmed with *I-V* curves and time-dependent phtoresponse.

5. Acknowledgements

This work was performed for the National Research Program for the 0.1 Terabit Non-Volatile Memory Development and National Research Laboratory , National R&D Project for Nano Science and Technology, National Nuclear Technology Program and Center for Integrated-Nano-Systems (CINS) supported by Korea Research Foundation(KRF-2004-005-D00087).