

Write-once-read-many (WORM) memory device using eco-friendly InP/ZnS quantum dots and PVK compounds

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This paper is about write-once-read-many (WORM) memory device based on InP@ZnS quantum dots. Proposed memory device showed an 4.5×10^3 of ON/OFF ratio at -0.5 V and maintained same on/off ratios for more than 100 hours.

Keywords: WORM memory, InP/ZnS quantum dots

1. Introduction

Memory is divided into volatile and non-volatile memory. Among them, a lot of research is being done on non-volatile memory. Non-volatile memory includes a ROM, flash memory, etc. Especially, the WORM (write-once-read-many) memory which can be permanently stored once it has been written has received considerable attention recently [1]. In addition, the quantum dot (QDs) is advantageous in that a quantum well exists even with a single material, and the charge can be stored. The characteristics of the memory device can be exhibited merely by forming the QDs thin film between two electrodes, and it is very easy to manufacture the device. The most commonly used substance as the core of QDs is cadmium (Cd) which is subject to Europe's regulation of the RoHS (Restriction of Hazardous Substances Directive) guidelines on harmful substances [2]. In this study, QDs with InP as a core were synthesized, and a memory device was fabricated and evaluated. The fabricated memory device has a write voltage of -3.8 V and an on/off ratio of 4.5×10^3 at -0.5 V.

2. Experimental

We synthesised colloidal InP/ZnS QDs. First, indium chloride (0.1 mmol), stearic acid (0.1 mmol), zinc undecylenate (0.1 mmol), hexadecylamine (0.2 mmol) were mixed in a 50 ml three-necked flask with methyl myristate or octadecene (3 ml) in nitrogen condition. Then, the solution is stirred and dissolved quickly at 280 °C. After that, we inject a (TMS)₃P-ODE (0.2 mmol) directly. We maintain the temperature at 240 °C, the InP core was synthesized. To make a shell, InP nanocrystal solution was cooled to room temperature. And, we added zinc diethyldithiocarbamate (0.15 mmol) and octadecene (2 ml) to the solution with nitrogen condition. Finally, we heated the solution to 230 °C [3]. The synthesized InP/ZnS QDs are dispersed in toluene at 1 wt%. To enhance the charge confinement effect in the QDs and to reduce the charge leakage in the QDs, the PVK mixed QDs solutions were prepared (PVK : QDs = 1 : 1.5) [4]. The patterned ITO glass was ultrasonically cleaned in acetone, methanol, and IPA. After that, we deposited QDs/PVK blending solution to fabricate the charge storage layer by using spin coating method at 3000 rpm and anneal it at 130 °C. Finally, the Al

electrode with a thickness of 150 nm was deposited by thermal deposition method. In order to evaluate the characteristics of fabricated memory device, voltage was swept from 0 to -5 V and from 0 to 5 V, respectively.

3. Results

The measured I-V properties have the bi-stable characteristics at negative voltage region. The fabricated device exhibited on/off ratio of about 4.5×10^3 at -0.5 V, and the write process at -3.8 V. Also, initial state was maintained even when a positive voltage, which is a common erase voltage.

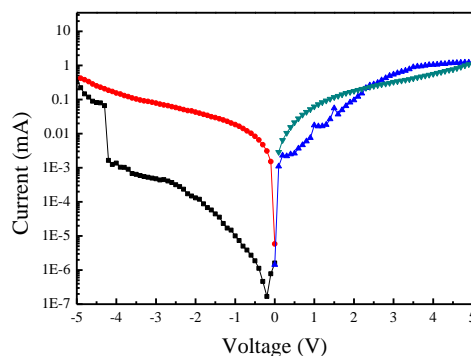


Fig. 1 The I-V properties of ITO/InP@ZnS@PVK/Al memory device.

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