Non-thermal plasma synthesis of silicon nanoparticles and its optical, electrical and photovoltaic properties

Yi Ding, Shu Zhou, Michihiro Sugaya, and Tomohiro Nozaki
Department of Mechanical Sciences and Engineering, Tokyo Institute of Technology,
2-12-1 O-okayama, Meguro-ku, Tokyo, 152-8550, Japan
E-mail: tnozaki@mech.titech.ac.jp

1. Introduction

Silicon nanocrystals (Si NCs) have attracted considerable attention in recent years. Besides the advantages of bulk silicon possesses, such as abundance, inexpensive, and non-toxicity; Si NCs have novel properties and vast applications in several kinds of devices. Photoluminescence from Si NCs can be tuned from IR region where bulk silicon emits light to visible, or even, UV region by reducing crystal size. Thereby, Si NC-based multicolor light emission diode (LED) has been achieved[1]. In addition, due to its tunable and strong absorption properties, efficient UV detectors and solar cells have been realized[2]. It also has potential applications in single electron devices, thermoelectric devices, lithium-ion batteries, and so on[3]. In this work, Free standing Si NCs with average size of 6 nm were fabricated from silicon tetrachloride by using non-thermal plasma. Detailed fabrication processes were described in elsewhere[4,5]. Synthesized Si NCs were carefully treated with hydrofluoric acid and followed by a slight oxidation in order to improve electrical properties. After that, the influence of crystallinity on its optical, electrical and photovoltaic properties has been studied systemically.

2. Experiment & Results

Raman spectra of particles synthesized at different power are shown in Figure 1; broad peak around 480 cm^{-1} is related to amorphous phase while sharp peak at 520 cm^{-1} is attributed to crystal phase. An obvious peak around 480 cm^{-1} can be detected from particles synthesized at 30 W, indicating most of particles are amorphous. Particle crystallinity increases with applied power, and particles synthesized at 65 W are almost all crystallized. Carrier mobility of different particles are obtained by making thin film transistor with structure as illustrated in Figure 2. In addition, silicon nanoparticle and conjugated hybrid solar cells were also fabricated as shown in Figure 3. Detailed device performance with different particles will be presented on conference.

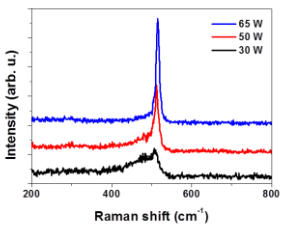

Figure 1. Raman spectra of silicon nanoparticles synthesized at different power.

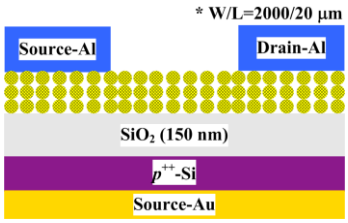

Figure 2. Schematic diagram of silicon nanoparticle transistor.

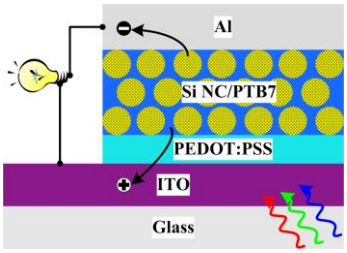

Figure 3. Schematic diagram of hybrid solar cell.

References

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