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Preparation of ZnO thin film with high-density quantum dots by particle size control

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Abstract: Solution-derived ZnO quantum dot is one of the most widely used electron-transport layers in optoelectronic devices. Achieving high-efficiency optoelectronic devices requires the development of low surface roughness and defects intensity for being used as ZnO quantum dot thin film. Herein, Alcohol solvents with different chain lengths were utilized to dissolve tetramethylammonium hydroxide to fine-tune the polarity of the solution, to achieve ZnO quantum dots with controllable particle size and monodisperse in alcohol solvents. Two kinds of ZnO quantum dots with particle sizes of 6 nm and 12 nm detected by DLS were successfully prepared by this method. Furthermore, by mixing these two types of quantum dots, ZnO films with a wide particle size distribution were fabricated, which exhibited lower surface defects density and surface roughness. This approach offers a novel pathway to reduce issues such as current leakage associated with ZnO as an electron transport layer. What's more, the small particle size ZnO quantum dots effectively fill the gaps between the large particle size quantum dots, resulting in a film with a higher density of quantum dots. This increased density contributes to the higher electrical conductivity of the ZnO film.

Size tuning of ZnO quantum dots:

ZnO quantum dots were prepared by previous literature. different particle sizes were obtained by changing the reaction solvent from ethanol to methanol, propanol, or butanol. (fig1 Size distribution of ZnO quantum dots prepared by different solvents determined in ethanol by DLS with (a) methanol, (b) ethanol, (c)propanol, and (d) butanol.)

Preparation of ZnO quantum dot film:

Ultrasonic cleaning of the glass substrates with deionized water, detergent, IPA, acetone, and isopropanol for 15 min in sequence. ZnO solutions were spin-coated onto the washed glass substrates at 1500 rpm. for 45 s. (fig2. Schematic diagram and surface morphology of ZnO quantum dot films. (a) Schematic diagram of ZnO S film and (b) ZnO L film and (c) ZnO M film (The mass ratio of ZnO S to ZnO L is 1:1). (d) AFM images of ZnO S film and (e) ZnO L film and (f) ZnO M film. (g) Linear surface topography of ZnO S film and (h) ZnO L film and (i) ZnO M film.)

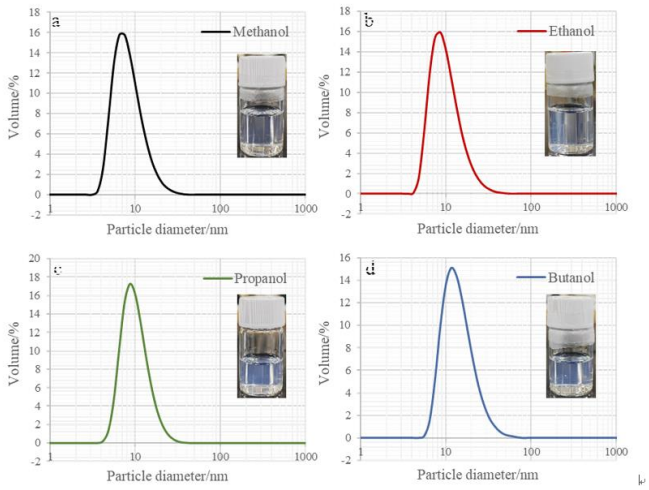

fig1

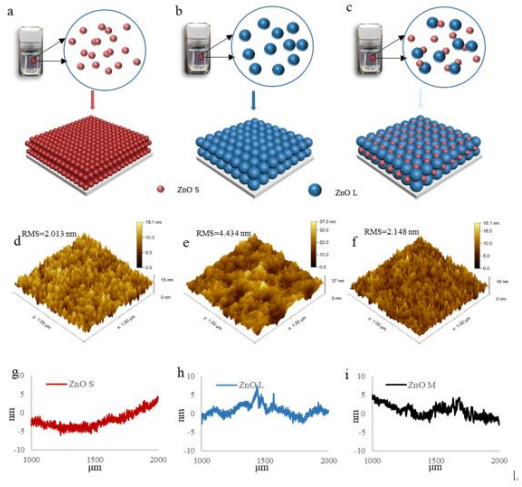

fig2

Preparation of ZnO thin film with high-density quantum dots by particle size control, ZHENG LIUBIN, and Kenji OGINO: Graduate School of Bio-Applications and Systems Engineering, Tokyo University of Agriculture and Technology, 2-24-16 Nakacho, Koganei-shi, Tokyo 184-8588, Japan, Tel: 042-388-7212, Email: s214514r@st.go.tuat.ac.jp