

Opponent review

Doctoral Thesis by *THAISKANG JAMATIA*

PREPARATION AND CHARACTERIZATION OF FILLERS FOR POLYMER NANOCOMPOSITE LAYERS USABLE IN ELECTRONICS

The submitted doctoral thesis deals with preparation and characterization of ZnO nanoparticles, undoped and doped with Fe and Al, used as nanofiller in polymer matrix and by preparation of polymer light-emitting diode with potential utilization in optoelectronics. The influence of water and oleic acid (OA) as the capping agent on ZnO nanoparticles preparation was investigated too. The theme and the obtained results are scientifically valuable and have potential to be utilized commercially.

The work is very nicely structured; it is readable and intelligible even if many words are used in unusual or strange meaning. But English grammar is good. I liked background that was logical and introduced a reader to the solved problem and it was supported by nearly 200 of actual references (about ten of them were published by the research group of the supervisor), which reflects topical research subject. I also appreciate short but sufficient explanation of principles of the used tested methods. It is evident that the work as a whole is the result of painstaking work. Research motivation was also nicely explained but I missed explanation of “why metal oxides” – nanoparticles seem to be described in general meaning.

From the formal point of view I must reprehend print screen presentation of particle size measurements by dynamic light scattering and titles of a few Tables and Figures that do not ascribe presented results, for example: Table 3.1 and 3.2: I do not see any reaction scheme; Fig. 4.31: Narrow scan means cut from longer/wider measurement conditions or really short measurement?; Fig. 4.52: I see the dependence of EL intensity on wavelength not the best performing PLEDs.

Do not write “below” in text for the reference of the Table or Figure – they are numbered, for example p. 26, Table 3.1.

I understand that it was used epoxy resin to cover the produced PLED but the resin is not specified in 3.2. Or is it?

The questions for discussion:

- p. 27: Is it really right that nanoparticles would form a “continuous phase”?
- In Fig. 4.38, what shows evidence that surface adsorption prevailed in Al-ZnO?
- How would you define “high crystalline nanoparticles”? Is it possible to prepare ZnO nanoparticles with low degree of crystallinity?
- The thickness of an OA monolayer shell on the surface of nanoparticles being 2–3 nm was judged or calculated? Would be possible to measure it, for example by AFM?
- How was determined the optimum thickness of the active layer in PLED being 30 nm?
- What does it mean that PLED with the best properties was 13 times brighter?

- You determined that Fe-doped ZnO nanoparticles caused drop in EL intensity but it also lowered the forward bias voltage needed to power the device. What is ideal or minimum bias voltage for PLED? Does it influenced time to or lightening of diod?
- It was stated in Background that durability of diode prepared by the method used in the work is short. What does it mean? Does it exist ideal value of durability?
- Is the title of y-axis in Fig. 4.45 correct? How it differed with that in Fig. 4.46?

Strange meaning or English: yellow “gamut”, “tap and harness” of potentials (p. 6); in the literature “like” – maybe such as (p. 7); is conducted at the high-T conditions (p. 7); a longer time (p. 12), a large number (p. 16); with high $\tan \delta$ (p. 12); device “fabrication” – maybe production, producing or manufacturing (p. 15); result in a composite not “the polymer” having (p. 17); of devices is a “must” under such conditions (p. 17); 3.3.4: different particles sizes; 4. Results and Discussions; 4.1: the paragraph above 4.1.1 is already in Experiment; the references to Figure/s in the sentence type in p. 32 “Fig. 4.2” should be referenced in round brackets – Fig. 4.2; the band gap is “eminent”? (p. 33); Is it really “excitonic” emission? (p. 35); not “on top of that” – you did not hike mountain (p. 61); The synthesis of Al-ZnO was “explored” by varying ...? (p. 62); by the same methods “(but XPS)”? (p. 62); lattice parameters size (p. 63); so Al-Z10 “alone” – Al-Z10 was really the only entity identified in FTIR spectrum? Or it was Al-Z10 itself? (p. 68); “exciton” band? (p. 68); The spectra are is depicted in Fig. 4.41 (p. 69); the opening bias was slightly decreased (p. 75); transition peak “eradicated” (p. 76);

Since the thesis consists of all prescribed parts, the goals of the work were fulfilled and the obtained results are scientifically valuable and of significant practical potential, there is no restriction to recommend the submitted doctoral thesis for defending it in front of the state committee. *Thaiskang Jamatia* can be doctored as “Ph.D.” if he/she defends the work successfully.



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