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TOPOLOGY OPTIMIZATION OF SILVER NANO-PARTICLES IN THIN FILM SOLAR CELLS

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Abstract
There are many advantages of using thin film solar cells such as low cost and various applications. However, the drawback interrupting the use of thin film solar cells in practical field is low energy transform efficiency. Therefore, various researches are performed to overcome the problem. One of those researches is using the surface plasmon effect. It is a kind of amplification effect caused by metal-dielectric interactions and generates a strong electric field around metal nano particles [1]. In this study, the surface plasmon effect was used for the efficiency improvement by inserting silver (Ag) nano-particles in the absorbing layer of a thin film solar cell [2-9]. The surface plasmon effect is sensitive to optical properties determined by shape of metal nano-particles [10]. To enhance the effect for improving efficiency, the appropriate shape of metal nano-particles should be determined.

This study adopts the topology optimization method in deciding the shape of metal nano-particles. The update algorithm used in the optimization process is based on the reaction-diffusion equation combined with the double-well potential function [11, 12]. Topology optimization based on the reaction-diffusion equation may be classified as a kind of phase field method which makes phase change occurs only around boundaries. Therefore, the optimal shape of metal nano-particle derived from the phase field method can avoid grey-scale problem and high computational load [12].

In this study, we designed optimal shape of Ag nano-particle by using the level-set method based on the reaction-diffusion equation for improving the efficiency of thin film solar cells. The simulation was performed using the commercial package COMSOL and Matlab. Optical properties used in the simulation and the optimization processes were determined at the specified wavelength of the incident light as 800nm since the thin film solar cell dose not absorb the incident light well, especially at longer wavelengths of sunlight. Finally, the efficiency improvement the thin film solar cell is checked via numerical simulations.

Keywords: Thin film solar cell, Phase-field method, Surface plasmon effect

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