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## 論文要旨

THESIS SUMMARY

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要旨 (英文 800 語程度)

Thesis Summary (approx.800 English Words )

For the realization of selective far- and near-field radiation transfer between the radiation source and the thermophotovoltaic cell, an infrared emitter and a TPV cell with nanometer-sized structures were proposed. In order to clarify the radiation properties of these emitter and TPV cell, which were dominated by electromagnetic field inside the nano-structures, the electromagnetic field around these structures were numerically calculated using a finite difference time domain method. In Chapter 2 of this thesis, a pillar array structure was proposed as a near-infrared emitters to enhance near-field radiation with limited frequency band, spectrally. As a component of the pillar array, two materials: aluminum doped zinc oxide (AZO) and tungsten were applied to utilize strong near-field radiation originated from surface plasmon polariton resonance (SPPR) and hyperbolic resonant mode. Through numerical simulations of electromagnetic fields around pillar array structured emitter and receiver made of AZO or tungsten, the electromagnetic waves inside the pillar array and surface wave propagating along the top surface of the pillar could be converted into the surface plasmon propagating on the surface on side wall of the pillar. Here, the side wall surface plasmon with a limited frequency was interfered with the pillar height equal to the channel depth between the pillars, similar to the Fabry-Pèrot interference. Consequently, the spectral near-field radiation transfer was controlled according to the pillar height and enhanced by interference. Moreover, depending on the dispersion relation inside the channel between two pillars, the Fabry-Pèrot interference with the channel depth corresponds to different frequency of the surface plasmon. Therefore, the same geometric pillar array structures made of AZO and tungsten had different radiation property in the near-field regime. In Chapter 3 of this thesis, a metal-semiconductor-metal (MSM) multilayer was proposed as a promised structure of metamaterial-TPV cell. In the MSM multilayer, the thickness of the photovoltaic semiconductor such as GaSb was reduced until several hundred nano-meter left depletion layer and the thin GaSb layer was sandwiched by two layers of gold electrodes with nano-structure. Absorptance of the MSM multilayer was evaluated using numerical simulation and the feasibility of MSM multilayered TPV cell for far-field radiation was discussed. It was found that the MSM multilayer with a fishnet structured electrode was proposed as a structure of TPV cell which absorbed a far-field radiation with a limited wavelength band. The equivalent cavity resonance of the fishnet-MSM multilayer reflected radiations with longer wavelength than the cutoff wavelength of the fishnet while absorbed radiations with target wavelength. Moreover, the MSM multilayer with an island structured electrode absorbs was also proposed as a structure of TPV cell which absorbed a far-field radiation. The island-MSM multilayer had several peaks of absorptance around near-infrared range of wavelength. It was found that the first peak that existed at the longest wavelength was originated from the resonance of the equivalent LC circuit formed around multilayer. Simultaneously, it was also found that the second peak was originated from the Fabry-Pèrot interference mode which was determined by the width of the island. From the comparison among absorptances of these multilayers, it was concluded that the fishnet-MSM multilayer was the best structure to absorb far-field radiation only with limited wavelength band. In Chapter 4 of this thesis, the pillar array structured emitter discussed at Chapter 2 and the MSM multilayered TPV cell discussed at Chapter 3 were combined to enhance the efficiency of TPV system using near-field radiation. Near-field radiation transfer between smooth plane made of AZO and the TPV cell was promoted using the island-MSM multilayer as the TPV cell. When the equivalent LC circuit resonant mode of MSM multilayer coupled with the SPPR of AZO, the near-field radiation transfer was highly enhanced at the frequency of SPPR. Furthermore, near-field radiation transfer between pillar array structured tungsten and the MSM multilayer was also promoted spectrally. Due to the resonant mode and interference mode of MSM multilayer with both fishnet and island electrode, the radiation flux with limited frequency band reached that of the blackbody. Moreover, with reduction of the reflection of the near-field radiation by increasing thickness of GaSb layer, the radiation flux could exceed the blackbody radiation at a frequency band.

備考：論文要旨は、和文 2000 字と英文 300 語を 1 部ずつ提出するか、もしくは英文 800 語を 1 部提出してください。

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