

## Reflectance of Carbon Nanotube Forest metamaterials

Wednesday, 11 July 2018 18:30 (15 minutes)

CNT forest of high emissivity, nearly ideal “black-body absorber[1]”, is attracting researchers as a candidate material for the future application of high-sensitive sensor, thermal energy storage device[2], and so on. Recently, metamaterials, electro-magnetic circuit to the incident EM-wave, opened a method to design desired optical properties. We recently reported CNT forest metamaterial in infrared and visible region in order to increase optical and thermal absorbance utilizing FIB nanofabrication [3, 4].

In this paper, metamaterials composed by 1D anisotropic refractive index material of CNT Forests, and the effect of nano-sized patterning on the optical and thermal properties are discussed. Figure 1 shows calculated UV-Vis-IR spectra of vertical- and parallel-aligned metal-nanorod CNT forests to the Electric field ( $E_z$ ) of incident EM wave, showing good correspondence to the experimental results[5] shown in Fig. 1(d-g). Components of perpendicularly aligned CNTs, which were parallel to the  $E_z$  of EM wave, increased reflectance in longer wave length region. Alignment of CNTs had an important role to improve absorption on the metamaterial patterns. Patterning shape effect of CNT forest metamaterials[3-5] will be also discussed in detail.

This work was supported by JSPS KAKENHI Grant Number JP 17K06205, and JP 24560050.

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Fig.1 (a-c) Calculated Transmittance, reflectance and absorbance spectra by meep FDTD program for the metal-nanorod CNT forests.  $E_z$  of EM wave was perpendicular to (a) x-axis and (b) y-axis of CNT alignment, and (c) parallel to z-axis of CNT alignment. (d, e) Highly vertically aligned CNT forests exhibiting low reflectance in 10-degree specular reflectance [5]. (f, g) Low-degree aligned (wavy) CNT forests showing higher reflectance in longer wavelength [5].

### Summary

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**Session Classification:** Poster Session