

## Design and Control of Photonic Fractals and electromagnetic Device

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### 【Outline of survey】

The objective of this study is to clarify the phenomenon of electromagnetic wave confinement in the three-dimensional fractal structures, which we have first discovered in the world in 2003 and named as photonic fractals, and to develop applications in information, communication, energy and sensing areas. We will establish the freeform fabrication technique using CAD/CAM system to fabricate Menger-sponge type fractal structures composing of dielectric, metal, and their composite materials with edge sizes of 30mm~300 $\mu$ m which can localize electromagnetic waves with a wide range from microwave to terahertz waves, and observe experimentally the localization behavior. We also promote theoretical calculations on the localized modes using super computer and investigate the correlation between the localization of electromagnetic waves and fractal structures. Based on these experimental and theoretical analyses, we will develop basic technologies to apply the localization function of photonic fractals to highly efficient antennas, filters, and perfect electromagnetic wave absorbers in microwave and millimeter wave ranges, and nondestructive sensors and portable terahertz wave generators in a terahertz wave range. This study will be a pioneering work to clarify and apply the propagation mechanism of electromagnetic waves in the self-similar structure of fractal which is essentially different from the periodic structure of crystals.

### 【Expected results】

This study has a large potential to develop a new academic area including physics, fractal science, materials science and engineering because it is not known about the propagation behavior of electromagnetic waves in three-dimensional self-similar structures which are essentially different from the periodic structures. In applications, it is expected to develop various new devices in information, communication, medical and other fields. Especially, terahertz wave would detect skin cancer, gunpowder and drug resulting in contributing to establish safe and secure society. We will develop photonic fractals in optical wave regions in future.

### 【References by the principal researcher】

- 1) M.W.Takeda, S.Kirihara, Y.Miyamoto, K.Sakoda and K.Honda, " Localization of Electromagnetic Waves in Three-Dimensional Fractal Cavities " , Phys. Rev. Lett., 92, 9, 093902-1-4 (2004)  
Y.Miyamoto, S.Kirihara, S.Kanehira, M.W.Takeda, K.Sakoda and K.Honda, " Smart Processing Development of Photonic Crystals and Fractals " , Int. J. Appl. Ceram. Technol. 1, 1, 40-48 (2004).

【Term of project】 FY 2005 - 2007

【Budget allocation】 84,600,000 yen

【Homepage address】 <http://www.jwri.osaka-u.ac.jp/~mril/>