Electromagnetic Metamaterial Project in Japan

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The project titled "Electromagnetic Metamaterials" (FY2010-FY2014, Project Leader: M. Hangyo) started last year after the preparation period of several years [1]. The project is supported by Grant-in-Aid for Scientific Research on Innovative Areas from The Ministry of Education, Culture, Sports, and Technology (MEXT), Japan. This project is the first systematic metamaterial project in Japan and unique compared with other metamaterial projects in the world in that it covers from microwave to optical regions. Figure 1 shows the logo of the project, which symbolically expresses the four quadrants of the permittivity-permeability parameter space. There are two approaches to realize metamaterials: 1. periodic structures like transmission lines by tightly combining metaatoms and 2. resonant structures utilizing the resonance of individual metaatoms. Considering the wavelengths and the approaches, the project is constracted of six planning research groups as shown in Fig. 2. The A01 team (groups a, b, and c) and the A02 team (groups d, e, and f) will carry out the research in the microwave & THz and optical regions, respectively. The theoretical subgroup is organized to solve

Fig. 1. Logo of the project.

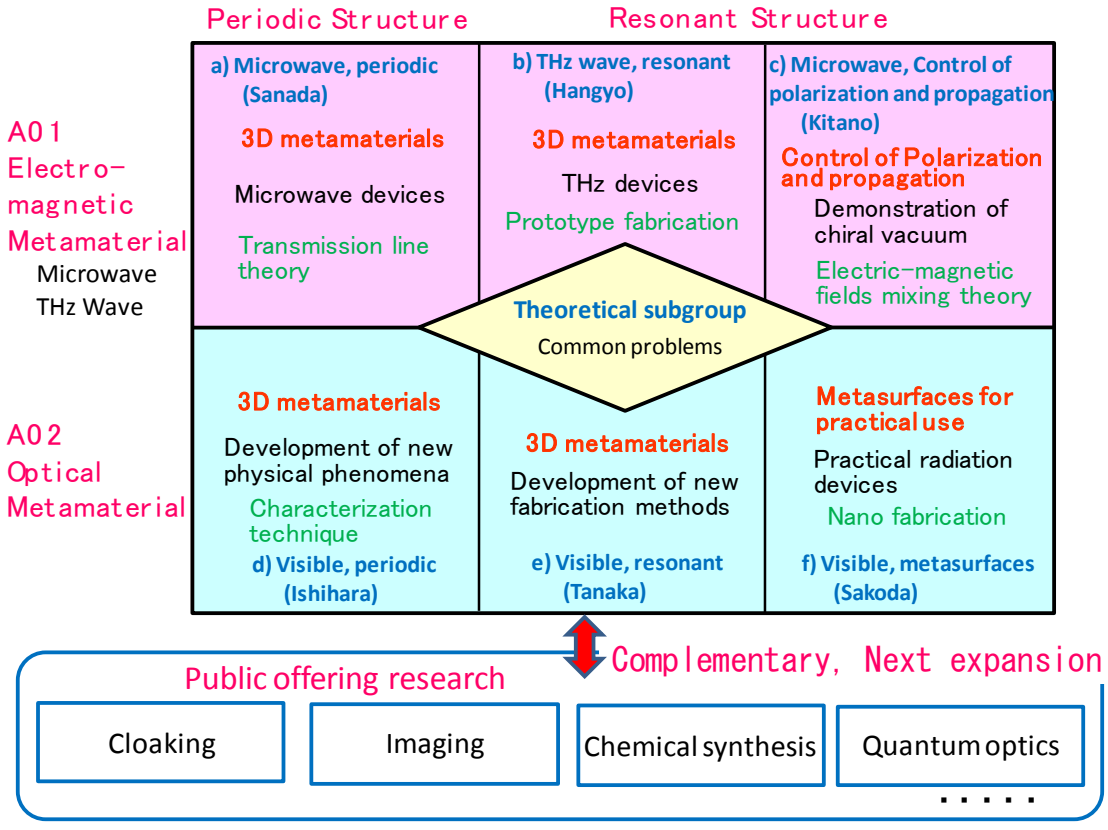

Fig. 2. Organization of the research groups.

common theoretical problems. All groups are connected tightly with each other. The main research targets are 1. design and fabrication of 3D metmaterials, 2. prediction and demonstration of novel phenomena, and 3. creation of novel devices. Public offering researches will include the important subjects not covered by the planning research groups and those lead to the future expansion of the field. The eleven first-period public offering researches (FY2011-2012) have been adopted recently.

Expected research achievements are shown in Fig. 3. The design and fabrication methods of 3D metamaterials will be established. Each group will try to fabricate 3D metamaterials using a variety of method appropriate to each wavelength region. The unique phenomena expected for metamaterials such as reversed Cherenkov radiation, reversed Doppler effect, and negative radiation pressure will be proved experimentally. The chiral vacuum, which is predicted theoretically for chiral metamaterials by Prof. Kitano and coworkers [2] will be proved experimentally. Further, novel devices using metamaterials will be realized. Especially, the new devices for communications will be realized in the microwave region and various active devices will be proposed for accelerate applications of THz technologies in various fields.

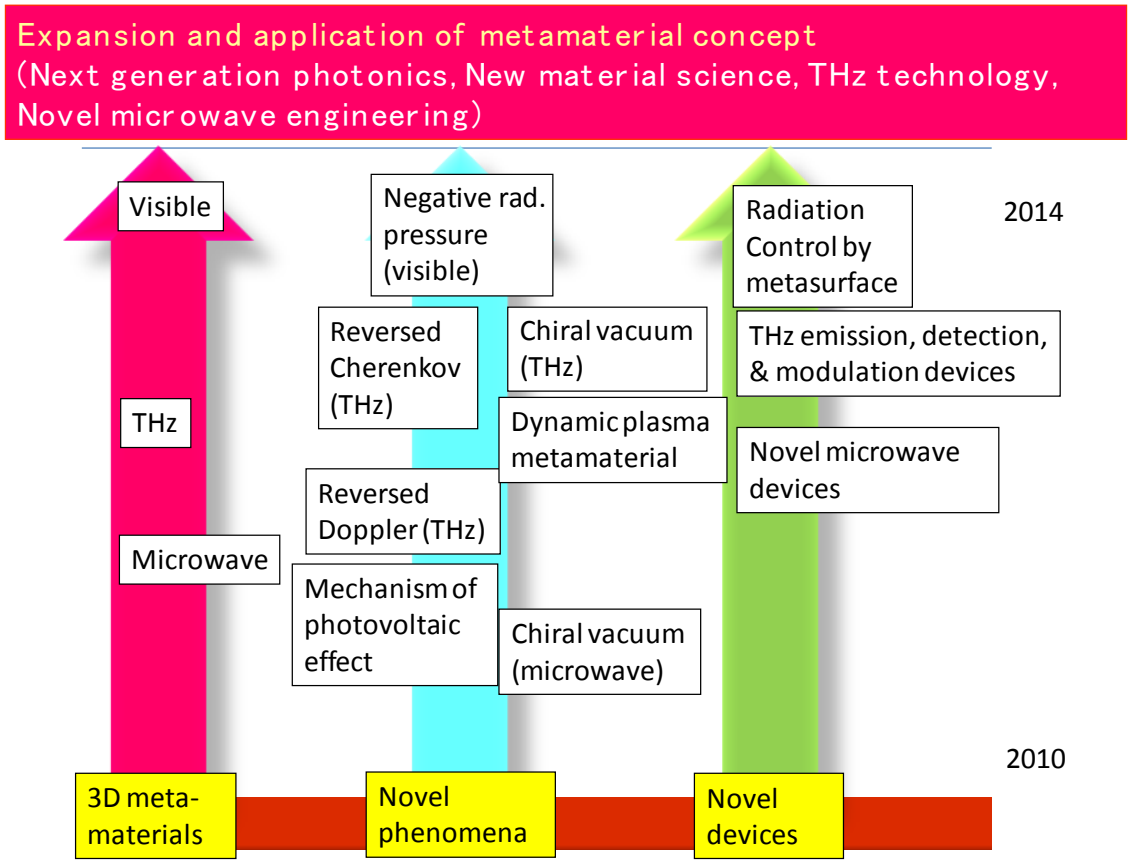

Fig. 3. Expected achievements.

References

1. http://www.metamaterials.jp/shingakujutsu (English wave page is now in preparation).
2. Y. Tamayama, T. Nakanishi, K. Sugiyama, and M. Kitano, Opt. Express **16**, 20869 (2009).