Study on non-thermal effects of exposure to 0.07-0.6 THz radiation to cultured cells

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Terahertz (THz) waves have characteristics of both radio waves and visible light. THz-waves are expected to create new technologies and applications such as communication, imaging, security and medical applications [1]. However, the number of studies on biological effects of the THz-wave is limited. Here, we assessed the biological and health effects of widely tunable THz-waves.

The aim of this study was to elucidate the Frörich hypothesis which tells that 0.1-1.0 THz irradiation may cause non-thermal effect on the cell membrane or on the biological systems [2]. We investigated cell proliferation and cell activity of three cultured cells. The cells were exposed to 0.07-0.6 THz for 3-94 hours by Uni-travelling Carrier Photodiode (UTC-PD, NTT Electronics Co.) as the light source. This light source is widely tunable source. To avoid the effect of heat generation due to irradiation, the output power was maintained below 10 µW. Using photomixing of two wavelength laser lights on the photodiode, the UTC-PD can generate MMWs in the range of 10 GHz to 1 THz and above at approximately 1 GHz steps [3].

Cell proliferation was measured for 96 hours by monitoring the electrical impedance. For this method, we used a dedicated measurement well (bottom area of 0.785 cm²), to the bottom of which was fixed an ultra-thin indium tin oxide (ITO) membrane electrode Cells that grow on the ITO electrode impede current flow, which changes the impedance value. A reactance ratio was calculated from this measured impedance value, and thus cell growth was indirectly measured. These results indicated no difference in reactance ratios between exposed and unexposed cells.

The cell activity measured by colorimetric assay using novel tetrazolium compound: MTS [3-(4,5-dimethylthiazol-2-yl)-5-(3-carboxymethoxyphenyl)-2-(4-sulfophenyl)-2H-tetrazolium, inner salt] (CellTiter96® AQueous One Solution Cell Proliferation Assay; Promega Co.). Colorimetric reaction assays are commonly used for tests of cell survival rates and cytotoxicity. 70 hours of irradiation did not significantly change cell activity rates of three cultured cells. And the cells exposed to 0.07-0.6 THz for 3 hours after cell cultured 72 hours, we found no significant decline in cell activity for exposed cells nor for sham cells

Our results showed that cells exposed to 0.07-0.6 THz were not affected by these waves in regards to cell proliferation and cell activity rates. Although cells were exposed during their growth, we did not identify any non-thermal effects. We found no cytotoxicity resulting from exposure.

References