Development of a passive infrared microscope towards noninvasive measurements of cultured cell temperatures

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A matter being in thermal equilibrium with heat bath emits thermal radiation having spectrum depending on its temperature, T (K). According to Planck's law, the black-body spectrum at 37℃ shows an intensity peak in the mid-infrared range (about 10 μm wavelength). Through passive detection of the infrared radiation, therefore, the temperature change generated by live cell activity should be noninvasively probed. In conventional thermography scheme, however, thermal monitoring of cultured cells is quite difficult because the infrared light directly radiated from live cells is not emitted to the environment (only thermal radiation from water surface can be detected as seen in Fig.1 (a)). Even though we consider to measure live cell activity through the temperature change of a culture solution, the radiation from the solution surface is largely influenced by heat of vaporization. We therefore have developed a unique measurement scheme in which the infrared light from live cells adhered on a substrate is picked up through the liquid-solid interface (Fig1 (b)).

Our infrared microscope consists of MCT (HgCdTe) photoconductive element (maximum sensitivity wavelength: 10 μm) and parabolic mirrors. The infrared light modulated by a chopper are measured by a lock-in technique. By carefully avoiding background radiation, the temperature resolutions are achieved to be about 30 mK . We prepared a capsule (a sample holder) made of polydimethylsiloxane (PDMS) with a germanium substrate. The sample (yeasts) are adhered on the substrate by using amino acid (Poly-L-Lysin solution). We compared the infrared signals between live and dead yeasts (prepared by drying) in a culture solution. The infrared contrast is found only for the dead yeasts. Because the dead yeasts are strongly adhered as a kind of contamination on the substrate, the contrast suggests the scattering of background radiation or the difference of emissivity from the solution. To probe the temperature change due to live cell activity, we may need to reduce the thermal conductivity of the substrate. In this poster, through our experimental results, we would like to discuss the points to be improved.

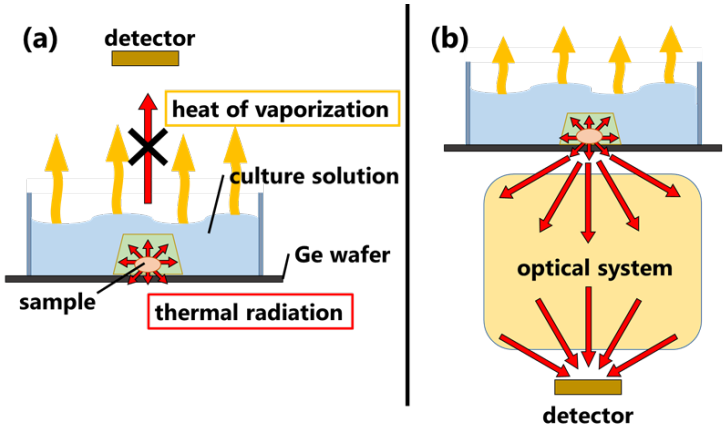

Fig.1 Comparison between a conventional thermography method (a) and our method (b)