

An Incubator Combined with TEM-cell for Cellular Electromagnetic Effects Study

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Abstract—Biological effects of electromagnetic radiation are drawing increasing attentions nowadays. Because of the individual differences and the position status variability, animal based bio-electromagnetics studies showed contradictory results and it's hard to illustrate the instant cellular response. To facilitate the cell based molecular mechanism study of EMF bio-effects, an integrated system combined a cell incubator with a TEM-cell was developed which shows a very good performance.

I. INTRODUCTION

Nowadays, people are exposed to many kinds of electromagnetic fields, such as the continuous waves (CW) and electromagnetic transients near the pulsed power equipments, which can affect different systems of living organisms [1]. Therefore, the biological effects of electromagnetic radiation, which is really an interdisciplinary area, are drawing increasing attentions from both physicists and biologists.

The study of EMF bio-effects could be carried out based on the whole animal exposure experiment or based on the *in vitro* cultured cells. The animal based study could demonstrate the integrated effects of the whole body responded to an EMF, but because of the animal individual differences and the position status variability during the electromagnetic radiation, the measured results are not entirely consistent, or with big deviations [2]. The cell based study could avoid the position status variability of animal experiment and the calculation of EMF bio distribution. Moreover, it could demonstrate the rapid response of cell and reveal the possible molecular mechanism under a given parameter combination of EMF[3].

While *in vitro* cell cultivation requires standard culture conditions such as temperature of 37 °C and 95% humidified environment with 5% CO₂. Change of the temperature or the pH of medium could activate or inhibit many cell signaling pathway and result in the cell behavior alternation. Therefore, maintain the standard cultivation environment during EMF treatment is of great importance to obtain the precise results for cell based study.

II. STRUCTURE OF CELL INCUBATOR

To establish the identical culture condition of the cells with or without electromagnetic radiation, the interior of the modified incubator was divided into an upper part (with normal culture environment) and a lower part (equipped with a TEM-cell cavity) (figure 1). A signal generator (continuous wave or pulse) is connected to the TEM-cell by cable connectors. The transverse electromagnetic (TEM) wave could be guided traveling through

the TEM-cell, and as a result, the cells inside TEM-cell would be illuminated by a pretty uniform EMF.

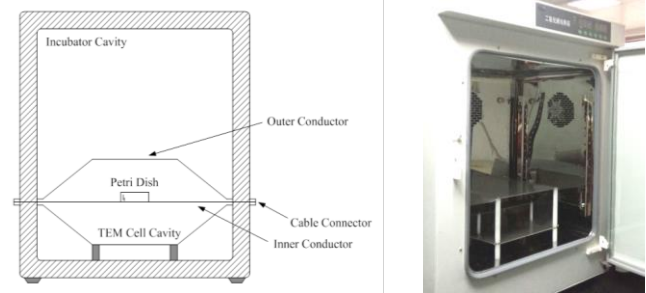


Figure 1. The structure and the photo of the modified cell incubator

The inner conductor and outer conductor are separated by insulators. A 50 ohm resistor with low inductance is terminated at the end to match the wave impedance of the TEM-cell. Some sealing technologies were adopted when designing the incubator to avoid the gas escape from the TEM-cell.

The strength of electric field inside the TEM-cell can be calculated as $E=V/h$, while V is the applied voltage to the TEM-cell and h is the half height of the TEM-cell.

The newly fabricated incubator has been running stably for a long period and some preliminary results will be presented soon.

III. CONCLUSION

A specific cell incubator has been developed for the research of electromagnetic field bio-effects. In this incubator, the electromagnetic field illumination and cell culture could be achieved simultaneously, which could be easier to illustrate the relations between the cells' response and the given EMF. This is the fundamental to enhance the reproducibility and reliability of EMF bioeffects study and is of great importance to illustrate the molecular mechanism of EMF bioeffects at the cellular level.

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