Ultraviolet Laser-Assisted Micropattern Fabrication and its Impact on Viral Activity Inhibition under Electrical Stimulation

Hsin-Yi Tsai*[12], Liang-Chieh Chao[1], Chih-Chung Yang[1], Yu-Hsuan Lin[1], Kuo-Cheng Huang[1], J. Andrew Yeh[2]

[1]Taiwan Instrument Research Institute, National Applied Research Laboratories
20, R&D Rd. VI, Hsinchu Science Park, Hsinchu 300, Taiwan

[2]Department of Power Mechanical Engineering, National Tsing Hua University
101, Kuang-Fu Rd, Hsinchu 300, Taiwan

*Corresponding author email: kellytsai@narlabs.org.tw

Viruses and bacteria spread rapidly through saliva or droplets, and their prolonged viability poses a serious threat to human health, especially during the COVID-19 epidemic. Therefore, the inhibition of virus or bacteria activity play an important role in surface treatment technology. Traditionally, virus inhibition involves chemical substance spraying or physical methods such as heat or ultraviolet light, all of which potentially harm the respiratory system, eyes, or skin oh human body. The other virus inhibition method was also presented such as electrical stimulation [1], acoustics, plasma, and microwaves. In addition, the metal surface such as cooper surface can destroy the ester and protein surrounding virus [2]. Thus, we used the copper surface and given a variable-frequency electrical stimulation for the virus and bacterial [3]. The results showed that the activity of coronavirus 229E can be significantly inhibited under direct-current pulse stimulation with 25 mA current and specific frequency. The laser system can directly fabricate the electrode and pattern on flexible materials, and it had excellent opto-electrical properties [4]. The previous research [5] presented that the electrical field emission properties can be enhanced by surface structing of copper film fabricated by laser system. Therefore, we integrate the micropattern induced by laser system and electrical stimulation on conductive materials to investigate the inhibition effect of viral activity. Micropatterns are created on conductive films using by ultraviolet laser system, which can enhance the effectiveness of electrical stimulation in inhibiting of virus activity. The conductive films include copper film that originally had good viral inhibition effect and ITO film that have excellent optical transparent effect. In addition, the micropattern with circle and rectangle shapes, and different dimension and spacing ranged from 50 to 200 μm were designed. By utilizing variable-frequency electrical stimulation, we explore the inhibition rates of 229E coronavirus under different dimensions, spacings, and shapes of micropatterns, aiming to achieve an inhibition rate of over 90%. Through the fabrication of micropatterns on the surface of conductive substrates, the sharp electric field effect can be enhanced and even reducing the time and power consumption required for electrical stimulation in viral activity inhibition. This advancement significantly broadens the application scope, efficiently reducing virus activity and providing substantial assistance to public health.

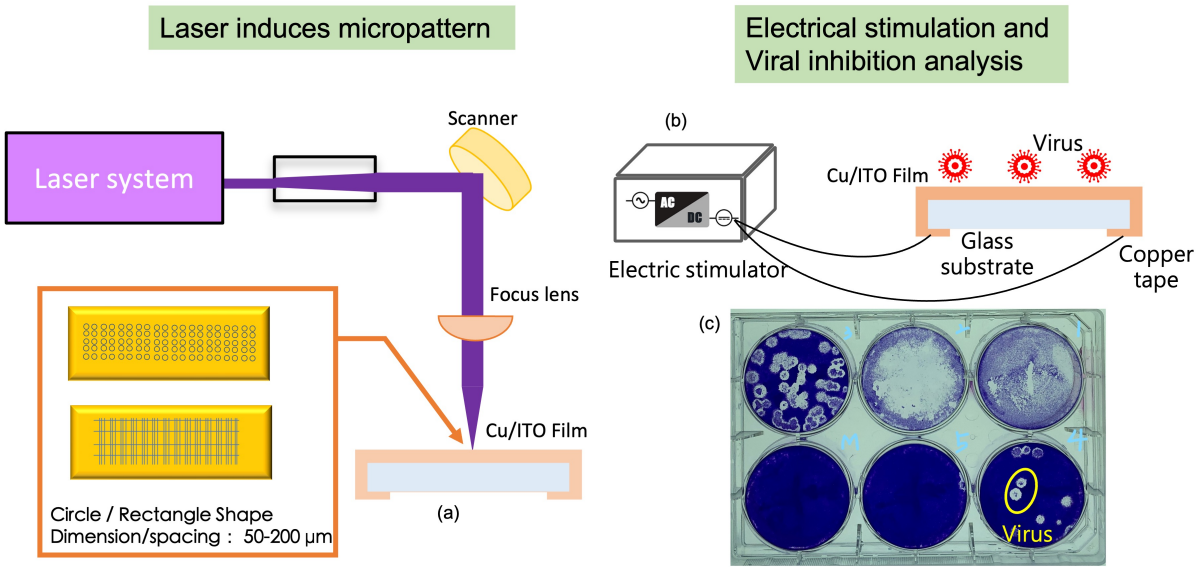

Figure 1: Schematic of (a) experiment setup and laser induced micropatterns on Cu and ITO film, (b) Electrical stimulation on virus through the laser-assisted micropatterns and (e) virus inhibition analysis in a virus plaque assay.

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