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IT-4-P-5765 E-BEAM CROSSLINKING AND THERMAL DEGRADATION OF HYDROGEL UNDER ELECTRON MICROSCOPE

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Introduction

In the past decades, hydrogel has been becoming an important medium for incorporating cells together to from 2D or 3D structures for tissue engineering applications.Electron beam can be used to pattern the resulting hydrogels on silicon or glass surfaces with nanoscale and microscale feature sizes by radiation crosslinking[1]. The water content plays a role to form the hydrogen and hydroxyl radicals which initialize the polymerization reaction. To visualize the dynamic evolution of hydrogel, we use a hermetic micro-device (wet-cell) to preserve the hydrated hydrogel in vacuum system under electron illumination. We has reported the innovation of self-aligned micro wet-cell and demonstrated the TEM examination of hydrated Deinococcusradioduransin our previous work[2]. In this paper, we furthermore introduce an advancing micro wet-cell with miniature heater integrated to achieve a temperature manipulating for the rapid recovering of hydrogel.

Chip fabrication and set up

The multiple-electrode wet-cell device is composed of two silicon chips with complementary structure, as shown in Fig.1.The “cover piece“, a 3mm x 3mm square-shaped device made of 250μm-thick Si wafer, has an observing window which is formed by the bulk micromachining and covered by a silicon nitride membrane; the “electrode piece”, a 3mm x 6mm rectangle-shaped device made of 250μm-thick Si wafer, consists of a similar observing window with additional Ni/Cr heater (200nm/50nm, 20.07 kΩ) as well as the extended metal pad for wire connecting.

Experiment Results

To measure the temperature rising with increasing applied voltage, we use an infrared-thermal microscope to visualize the distribution and variation of temperature. Several different applied voltages and their corresponding temperatures are shown in Fig.2 . We can control our heater temperature ranging from 30 to 70 °C, reversibly. We also used the Hitachi TM-1000 and made a circuit on the side wall of the SEM, so that we can directly applied tunable voltage in the vacuum system. We first applied the e-beam radiation onto the specific region of GelMa. In Fig.3a-b, electron radiation posses higher effect on GelMa as we zoom in the field of view.The cross-linked regions, as shown in Fig.3 c-d, can be approximately characterized as 1,973μm^2. The degradation of the hydrogel was observed after heating, and the cross-linked regions has been fully dissolved at a temperature of 50.2°C.Finally ,the detail results will be discussed in detail in the conference.

REFERENCES:

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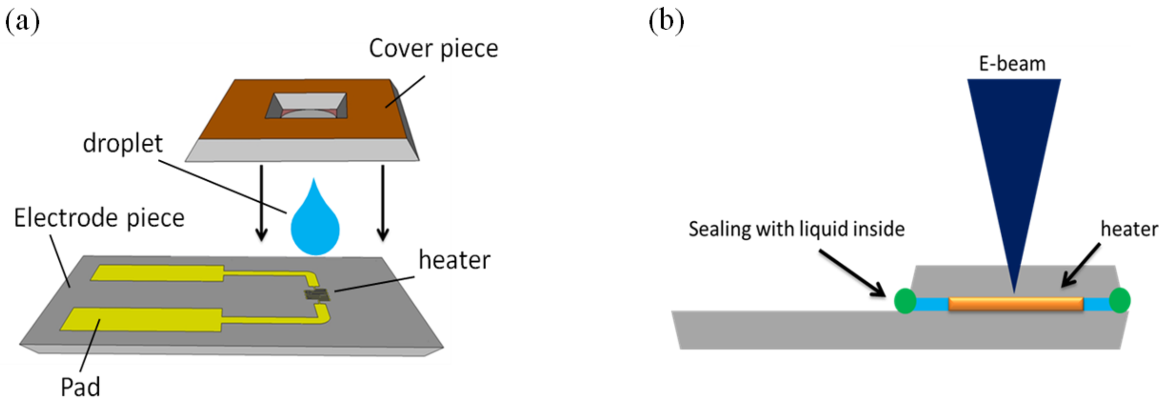

Fig. 1: Figure 1.(a)Schematic of two parts of our device assembly (b)Schematic of E-beam and chip observing area

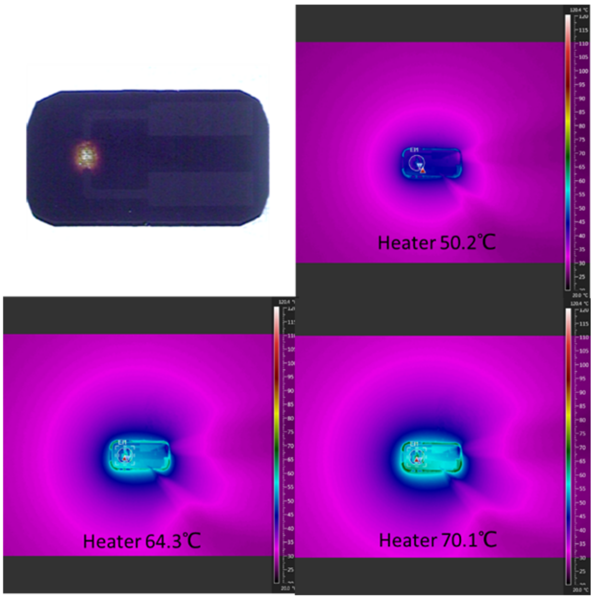

Fig. 2: Figure 2.IR microscope image of our device heatingby applied voltage from 50.2℃ to 70.1℃

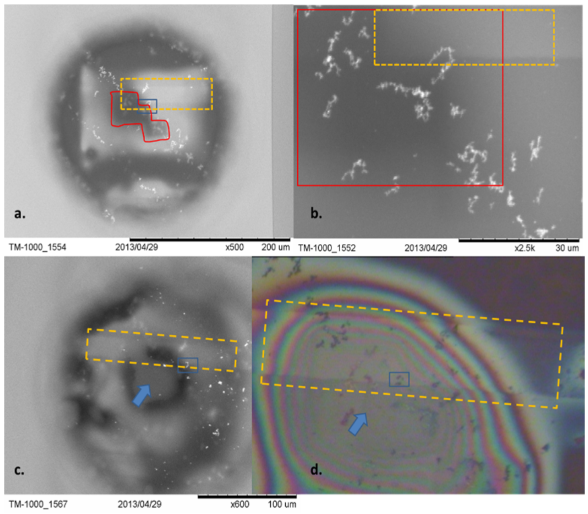

Fig. 3: Figure 3.Orange frame is the electrode part . Blue frame is the unchanged part. (a)-(b)electron radiation affected GelMa as we zoom in (red frame region). Heating result is acquired after e-beam treatment. (c)-(d) Due to heating, the contrast of a pointed region is changed which can be observed in SEM but not in OM