3 - 78 Recruitment Kinetic of DNA Repair Protein XRCC1

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Ion microbeam has become a powerful tool to investigate intracellular responses to ion irradiation. In order to study the dynamics of protein recruitment to DNA lesions[1−3], we set up a live cell imaging (LCI) system which allows us to online study the fast recruitment dynamic of single stranded break (SSB) and double stranded break (DSB) proteins at the IMP heavy ion microbeam facility.

We used human fibrosarcoma cell line HT-1080 expressing RFP-tagged XRCC1 for microbeam irradiation to study the cellular response to SSBs[4]. Cells were line-scanned slowly by single Ni ions at 0 s, and then imaged for 300 sends with 10 s interval. The microscopic images of the RFP fluorescence of each cell nucleus in the microbeam-irradiated field were obtained with the LCI system and analyzed by the Focipicker3D program(Fig. 1). The XRCC1 protein was recruited to the ion hit positions very fast and formed bright fluorescent foci in the cell nucleus. The fluorescence intensity of the irradiated position inside the cell nuclei was extracted and fitted with the followed equation,

$$I_{\mathrm{rel}} = \begin{cases} I_0\ , & (\mathrm{fort} \le T_0)\ , \\ I_0 + I_1 \times (1 - \mathrm{e}^{-\frac{t-T_0}{\tau_1}}) \times \mathrm{e}^{-\frac{t-T_0}{\tau_2}}\ , & (\mathrm{fort} > T_0)\ , \end{cases}$$

where T_0 indicates the response delay of the tagged-protein, τ_1 and τ_2 represent time constant of the recruitment and the release of the XRCC1 protein in the response to Ni ion irradiation. I_0 is the original relative foci intensity and I_1 is the maximum intensity (Fig. 2). The relative foci intensity (Irel) is normalized to the mean intensity of the whole nucleus. Fig. 2 shows that the recruitment of the XRCC1 protein followed the exponential increase and decay model very well.

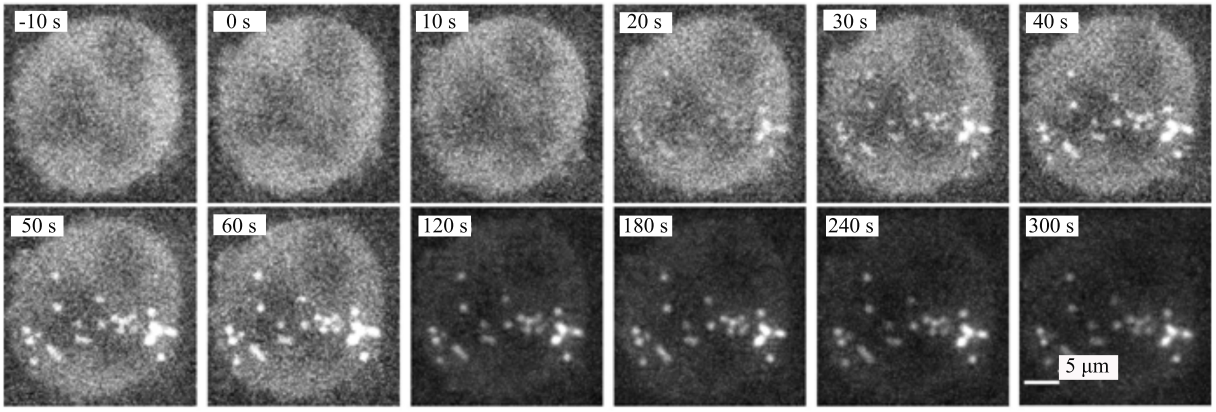

Fig. 1 HT1080 cells expressing XRCC1-RFP form bright foci at the irradiation positions of single Ni ions.

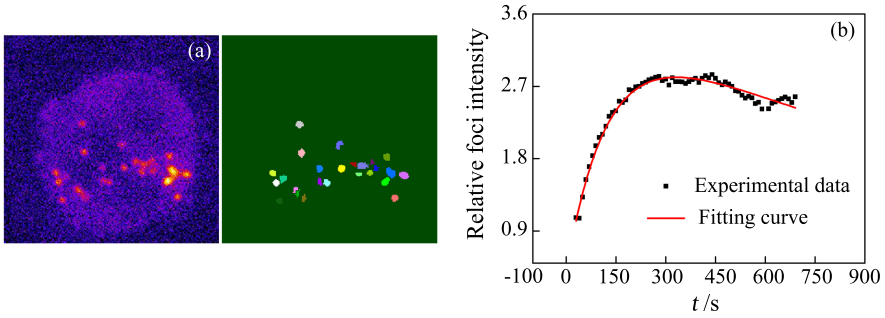

Fig. 2 (color online) Kinetic analysis of the XRCC1 protein at the irradiated positions. (a) Original cell image shows bright foci in the nucleus after radiation by the single ion beam line. (b) Using Focipicker3D program to get the picture shows the foci position, size and the intensity information. The right chart shows the original data and the curve fitting very well.

References

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3- 79 Single Event Effect Mapping System at the IMP Micro-beam

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The micro-beam is a beam of micrometer or sub-micrometer dimension, which allows precise defined quantities of ions to be introduced at precisely defined location. It has been a powerful tool for single event effects (SEE) study. At the IMP micro-beam facility, we have preliminarily built a SEE mapping system to study the microscopic sensitive areas of SEEs on integrated chips.

In order to map the SEE distribution with the ion irradiation, the SEE event signal (E) from the device under test is detected by the analog input of the SEE mapping system; through the SEE mapping software control, the beam is scanned with the magnetic scan coil of the microbeam facility and the beam position of the scan coil of the microbeam facility is used to register the SEE position (X, Y); Finally, the SEE distribution is drew with a pseudo-color bit image online using (N_{E}, X, Y), where $\mathrm{N_E}$ is the number of occurrence of SEE type E at beam position (X, Y). The input of the SEE mapping system can support simultaneously detection of up to three SEE signals.

Recently, a micro-beam experiment to explore the single event upset (SEU) in SEE was performed. Totally 73722 ions were scan-irradiated over an area of 468 μm × 403 μm, and finally 633 SEU events were detected. The left imagein Fig. 1 shows the microscopic SEU sensitive image on the tested FPGA of Actel Pro ASIC Plus APA600, the black dots represent the relative location where SEU occurs. In addition, the allocation of the configured register resources is shown on the right side in Fig. 1, it's obvious that the SEU distribution trend matches with the structure of SRAM. Overall, the SEE mapping system can be used to map the sensitive area of single event effects in microelectronics.

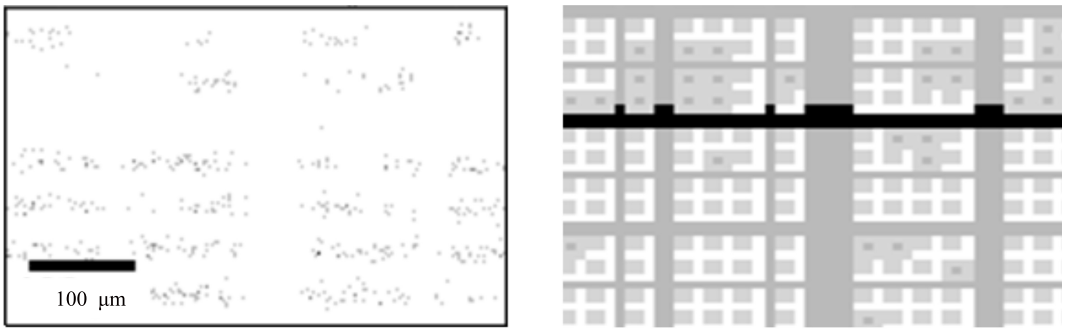

Fig. 1 The image on the left shows the distribution of 633 SEU induced by the micro-beam, and the image on the right is the allocation of the register resources.