Ultra-Low Noise Detection via 2 Stage Peltier-Cooled CCD

INTRODUCTION

For weak chemiluminescence signal detection, users enhance their signal intensity by various methods: extend the exposure time, accumulate signals from multi-captures, use higher Gain value, or turn on the Binning function. However, all of these functions increase background noise due to the dark current production while CCD operation. Dark current is the small electric current that randomly flows through every pixel and is positively correlated with the CCD temperature. While long term operation, as the CCD temperature gets higher, the more dark current is produced. Peltier cooling device is like a heat pump that utilizes thermoelectric conversion to transfer heat from CCD to environment. Wealtec's KETA ML imaging system equipped with 2 stage Peltier cooling device, a superior cooling technique, which can lower CCD temperature down to -45℃ hence to ensure users getting the images with the best signal-to-noise ratio. In this article, KETA ML which has the remarkable cooling effect will be taken as a typical model.

MATERIALS

- KETA ML imaging system (Wealtec)
- Goat-anti-mouse-IgG-HRP(Santa Cruz)
- Chemiluminescence: ECL Enhanced Chemiluminescence reagent (Millipore)
- NC membrane (PerkinElmer)
- TBST buffer

PROCEDURES

1. Goat-anti-mouse-IgG-HRP antibody was diluted to proper concentration as following:

Spot	1	2	3	4
Protein amount (pg/μL)	22.22	7.407	2.469	0.823

2. NC membranes were pre-treated with TBST buffer, and air-dried for 10 minutes.
3. Diluted antibodies (1 μL) were blotted onto NC membrane.

4. ECL substrates were added onto membrane.
5. Chemiluminescence signals were detected by KETA ML imaging system with or without 2 stage Peltier cooling device.

RESULT

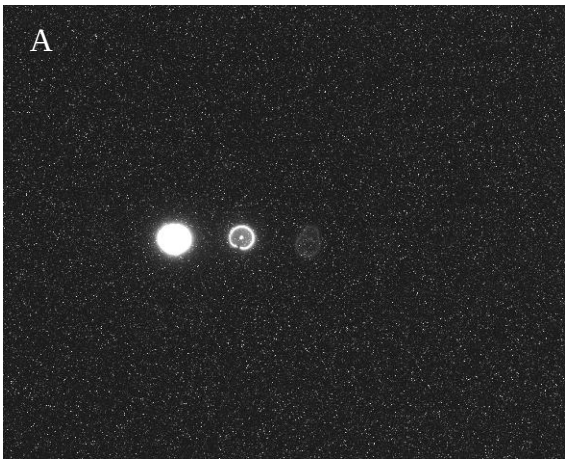
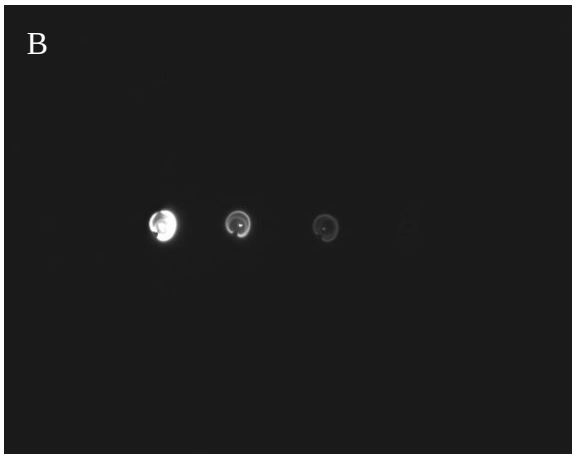
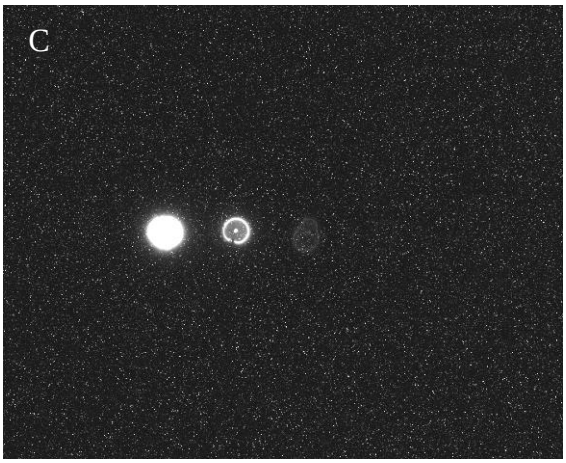
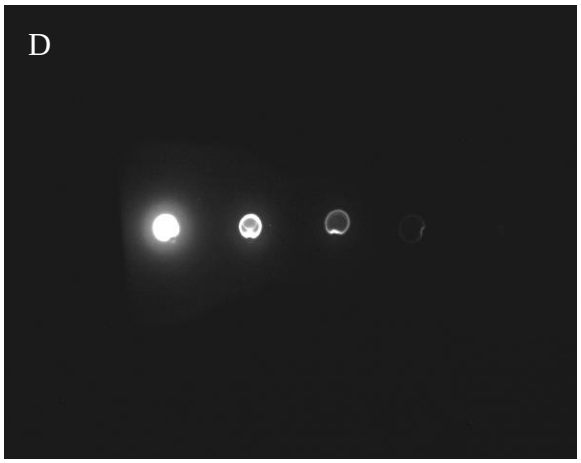
	Without cooling device	With cooling device
Gain 230		
Gain 310		

Figure 1. *Chemiluminescence signal detection by KETA ML imaging system with or without 2 stage Peltier cooling device. Exposure time: 15 minutes by DynaView function*

DISCUSSION

While detecting weak signals, especially in chemiluminescent experiments, cooling device is the essential equipment. It can not only lower down the noise signal produced from the dark current, but also increase the distinguish ability from signal to noise. As shown in *fig*. 1A, with extending the exposure time for 15 minutes without any cooling device resulted in high-noise background. In contrast, with the help of 2 stage Peltier cooling device to cool down the CCD and dramatically increase S/N ratio, it resulted in much clear image as in *fig*. 1B. Besides, while using higher gain value to enhance the signal intensity, cooling system plays more important role on distinguish the signal from noise. As shown in *fig*. 1D, gain value of 310 with cooled CCD allowed lowering down the detection limitation to the weakest spot (spot No. 4), whereas without cooling device it was hard to tell the signal from the high-noise background (*fig*. 1C). Although the detection limit is higher in *fig*. 1D, the background signals from the membrane also brighter and the first spot had already saturated.

In the conclusion, while detecting tiny chemiluminescence signal, Peltier cooling device, which especially with 2 stage Peltier cooled system, is the very first absolutely necessary tool for increasing the capturing ability. About the gain value, it just the assistant tool and need to be adequate adjusted after having the cooling system.

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