Digital video cameras to supervise and document hot laboratory processes

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Abstract

Precision processes conducted in hot laboratories need sometimes supervision and documentation from other observation angels than possible through the hot cell window. Digital video cameras have proven useful tools in supervision and documentation. For application in a hot-cell the relevant question is how much irradiation do the electronics in digital cameras withstand?

For the fabrication of mechanical test specimens of irradiated steels in hot-cell milling operations a video camera with suitable optics was needed to be installed close to the work piece in the hot cell to allow supervision of the mounting operations of the work piece in jigs and fixtures and the high precision CNC micro milling. In search for a small, light, compact, inexpensive digital video camera with suitable optics a “Internet video and digital still camera” used normally for video communication and digital photography has given proof to satisfy the demands. In this paper information is given on radiation exposure of the camera and its documentation capabilities. Further, in the presentation the quality of a process supervision video is demonstrated showing examples of micro milling of compact tension samples with irradiated steel inserts and micro milling of tensile tube specimens for slow strain rate testing.

Digital cameras in hot cells

Introduction

To perform operations in a hot-cell with high precision, to do close-up observations or to do observations under different angles than achieved through the hot-cell window viewing aids such as binoculars, mirrors, periscope etc. are in use. However, when hot-cells (see Fig. 1) are not equipped with a periscope and the windows are to dark to do close up observations, a digital video camera installed inside the hot-cell might be a more efficient aid. Over a longer period of time we were looking into the market of such cameras. There are commercial video camera systems produced for operation in radioactive environment. However, these cameras are expensive and often rather large and heavy. Over a number of years when producing compact tension specimens with irradiated steel inserts 2) by in-cell remotely handled CNC precision milling (see Fig. 2) there was a strong wish to follow the operations visually and more close-up to detect immediately poor work piece mounting or irregularities in the process.

Experimental

Radiation damages the electronics in standard digital cameras relatively fast. Therefore, a digital video camera was wanted with as little electronics as possible to be exposed to radiation. Further, the camera should be small, light, easily replaceable, and inexpensive.

For process supervision in motion and sound an “internet video and digital still camera” used normally for video communication and digital photography seemed to be interesting 3) see Fig.3) 3). With a USB-interface the camera is connected to a computer outside the cell for recording and viewing (see Fig.4). On the screen of the on-line computer processes observed inside the cell can be followed/supervised. Easily, the small and light camera can be mounted and moved with a manipulator to the right observation position in the hot cell. Video film and stills taken with the camera have a medium resolution of 640x480 pixels (HI) or 320x240 (LO). With the camera limited direct off line recordings can be done. At a later stage such data recorded can be transferred with the USB-interface cable to the computer.

Contributions to the radiation level the camera is exposed to in the cell are from the background, namely contamination in the cell and radiation coming from the adjacent cells, and from the direct radiation. Direct radiation originates primarily from the irradiated steel work-pieces placed some 20 cm away from the camera and from irradiated fuel-rods being frequently handled in the cell at 1.5-2 m distance from the camera. A rough estimate of the total radiation level the camera would be exposed to amounted to some 40 Sv/year. Direct radiation during micro-milling was in the range of 100-300 mSv/h (Co60). The background radiation in the cell was some 0.2-0.3 mSv/h. The camera has survived until now 275 days of exposure in the cell (see Fig.5). The dose rate was estimated to be 30 Sv.
Results

The camera has a fixed, manually operated focus of >20cm. With the imaging software video recordings can easily be handled and still images be extracted (see Fig.6-8). The motion pictures have a medium image resolution and satisfactory sound quality.

Conclusion

The “internet video and digital still camera” used normally for video communication and digital photography has rather good, but limited radiation resistance. For the purpose needed the camera fulfilled the expectations. The digital camera installed in a hot cell has proven a useful tools in supervision and documentation of the micromilling process.

References


Figure 1  Cell for milling operations

One of the plugs under the cell was used to take the interface cable from the camera inside the cell to the computer outside the cell.

Figure 2  Hot milling machine
Figure 3 Logitech Quickam Traveler. (Camera manual)

Figure 4 Camera connection to the PC
Figure 5 Irradiation history of camera

![Irradiation history of camera](image)

Figure 6 Capture software from Logitech

![Capture software from Logitech](image)
Figure 7 Example - Picture taken with the camera with 640x480 pixels. Vice on the milling machine

Figure 8 Example - irradiated CT in a jig

Radiation of CT: 200mSv/h at 20 cm (camera)