SHOP NOTES

These are "how to do it" papers. They should be written and illustrated so that the reader may easily follow whatever instruction or advice is being given.

Video recording of low intensity CEMA images

J. A. Panitz

Sandia Laboratories, [a] *Albuquerque, New Mexico 87185*
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This note describes an inexpensive assembly of commercially available TV components that can be used to observe, record, and display low-light-level visual images. The resulting TV system has been in use in our laboratory for almost two years to analyze static field-ion and transient field-desorption images[1] which appear on the fluorescent screen of a curved, Chevron Channel-electron-multiplier-array (CEMA) detector[2] operating in ultra high vacuum. If the TV system is connected to the video input of a commercial image digitizer,[3] CEMA images can be digitally stored and processed in real-time. Visual LEED and ESDIAD[4] data can be easily analyzed in this manner.

After testing several TV cameras for their low-light-level imaging capability, a camera[5] incorporating a 9.5 mm newvicon tube[6] and an $f0.7$ TV lens[7] was chosen. Each camera-newvicon (or vidicon)-lens combination was judged by its ability to observe the random, dark-current image spots which appear on the fluorescent screen of the CEMA detector at high gain (10^6). A brighter image of better quality was obtained by mounting a 4:1 conjugate, low distortion lens[8] onto the TV camera in place of the TV lens.[7] In this case, the 6.6×8.8 mm active area of the vidicon tube restricted the field-of-view of the camera to a 26×35 mm region of the CEMA screen.

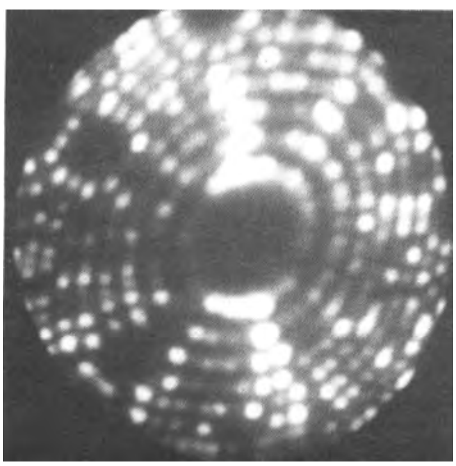

FIG. 1. A static helium-field-ion image of tungsten at 20 K and 1×10^{-5} Torr helium, photographed from a video tape recording during playback.

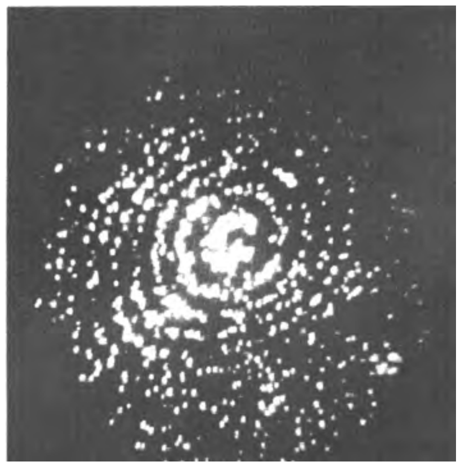

FIG. 2. A dc field-desorption image of tungsten at 20 K and 8×10^{-10} Torr, photographed from a video tape recording during playback. The dc evaporation rate of the tungsten lattice (recorded in real-time on the video tape) was approximately one (110) plane/s.

The TV camera was connected to a commercial 19 mm cassette video recorder[9] which in turn was connected to a high-resolution, flat-field TV monitor.[10] To enhance image contrast, an image processor[11] was usually connected between the TV camera and video recorder. Figures 1 and 2 show images obtained in this manner by photographing the TV monitor during the playback of a portion of a video tape. Since the vertical resolution of the 525-line standard TV system is approximately 343 lines,[12] viewing the entire 73 mm diameter fluorescent screen of the CEMA detector (as in Figs. 1 and 2) provided an effective image resolution of only $343/73 = 4.7$ lines/mm. This is approximately a factor of six poorer than the resolution which can be obtained from direct contact prints of the fluorescent screen,[2] and about a factor of 20 worse than the resolution which can be obtained by photographing

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the fluorescent screen with Tri-X[13] professional film. Using the 4:1 conjugate lens to view a circular area of the fluorescent screen 26 mm in diameter resulted in a TV image resolution of $343/26 \cong 13$ lines/mm, an improvement in resolution by almost a factor of three.

The standard TV scan rate permitted a reasonably detailed, time-dependent history of CEMA images to be made, provided a single image of interest persisted for several video frames. Since the TV scan rate is 30 video frames per second, the scan time for one video frame is $1/30 \cong 30$ ms, and consequently the image of a transient event lasting a shorter time will be incompletely recorded. To insure that the image of a transient event appears on several video frames, a fluorescent-screen phosphor with a decay time of the order of 100 ms should be used. As a result, only ten changes in a CEMA image per second will be accurately recorded.

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[1]E. W. Muller and T. T. Tsong, *Field-Ion Microscopy: Principles and Applications* (Elsevier, New York, 1969).
[2]J. A. Panitz, Prog. Surf. Sci. 8(6), p. 219 (1978).
[3]The Quantex Corporation, Sunnyvale, California (Model DS-20).
[4]T. E. Madey and J. T. Yates, Jr., Surf. Sci. **63**, p. 203 (1977).
[5]The Radio Corporation of America (RCA Model TC1005/NO2).
[6]The Radio Corporation of America (RCA Newvicon Model 4905).
[7]Cannon U.S.A., Inc., Optical Products Division, Lake Success, NY (TV-16, f0.78, 25 mm focal length).
[8]The Farrand Optical Company, New York, NY (Super Farron, *f*0.87, 72 mm focal length).
[9]U.S. JVC Corp., Maspeth, NY (JVC Model CR6060U).
[10]Tektronix, Inc., Beaverton, Oregon (Model 634).
[11]Microtime, Inc., Bloomfield, CT (Image-EX image processor).
[12]*Video Transmission Techniques*, edited by G. W. Bates, D. A. Keller, R. A. Jacobs, and J. E. Hansen, Jr. (Dynair Electronics, San Diego, CA, 1968), p. 14.
[13]A registered trademark of The Eastman Kodak Company, Rochester, NY.