Reprinted from THE REVIEW OF SCIENTIFIC INSTRUMENTS, Vol. 41, No. 10, 1408–1409, October 1970
Printed in U. S. A.

A Fluorescent Backlighting System for Observing High Pressure, Low Temperature Phase Equilibria Phenomena

MARK R. ENSIGN AND PHILIP C. TULLY
Helium Research Center, Bureau of Mines, U. S. Department of the Interior, Amarillo, Texas 79106
(Received 13 April 1970; and in final form, 25 May 1970)

An electro-optical system for observing high pressure, low temperature phase equilibria phenomena has been tested at 25 $MN \cdot m^{-2}$ and liquid nitrogen temperatures. The system consists of a uv source exciting an intracell fluorescent pigment which illuminates the cell interior. The cell is observed by a closed circuit television camera and monitor, and a permanent record is made with a video tape recorder.

INTRODUCTION

SEVERAL interesting critical phenomena have been observed in our low temperature phase equilibria laboratory without a permanent record being made. To prevent this happening in the future, a system consisting of a closed circuit television (CCTV) camera, monitor, and video tape recorder (VTR) was purchased.

Two problems prevented the effective use of the system as purchased. The first was the absence of an adequate means of illuminating the cell interior. The second was an inadequate image size of the cell interior and its contents on the monitor because only a 1:1 image-to-object size ratio was achieveable. This provided only a 1×4 cm image of the cell window on the CCTV monitor.

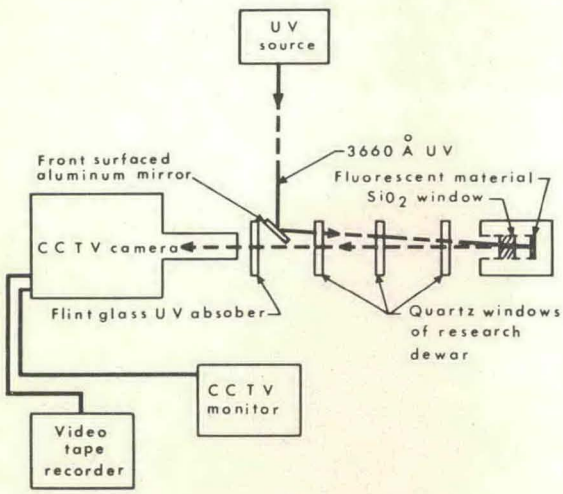

FIG. 1. Electro-optical system (schematic).

THE SYSTEM

The system for observing high pressure, low temperature phase equilibria phenomena consists of the following major components: a Sylvania model 600 CCTV camera[1] equipped with a Sylvania 25 mm, $f/1.9$ lens, and a Meyer Trioplan 90 mm, $f/3$ lens; a Sylvania model VMR 14 CCTV monitor with a 30.5 cm diagonal screen; a Sony Videocorder, model SV 300; and a blacklight Eastern Spectroline model B-100 uv source equipped with a spot bulb producing a 6.5° beam.

The schematic diagram of the system is shown in Fig. 1. From the uv source, a filtered beam of 3660 Å light is reflected from a front surfaced aluminum mirror into the cell interior. The rear of the cell chamber is coated with a fluorescent pigment, supplied by United States Radium Corporation, color No. 2205, which is excited by the 3660 Å ultraviolet and emits in the blue region with its emission peak at approximately 4500 Å. This peak corresponds to the spectral sensitivity peak of the Sylvania 1319 (RCA 7038) vidicon tube in the CCTV camera, thereby providing maximum image brightness.

The emitting fluorescent pigment provides a backlighting illumination that yields excellent image contrast of the vapor–liquid meniscus. The emission of the fluorescent pigment and the image of the meniscus then pass through fused silica cell window, the quartz Dewar windows, and a piece of flint glass, which absorbs any stray uv light, and into the lens–CCTV camera complex.

The Meyer Trioplan 90 mm $f/3$ lens is used in combination with a set of 1–80 mm variable lens extension rings. This feature provides the desired image magnification up to approximately 30 times, permitting as little as one fourth

of the cell interior to be enlarged to fill the entire monitor screen.

The electronic signal generated by the CCTV camera is generally fed to the video tape recorder, and from it another signal is passed on to the CCTV monitor. This provides a check on what is actually being recorded.

TESTING THE SYSTEM

A phase equilibria cell with a 1×4 cm rectanglar window was used. Before assembly, the rear of the cell interior was coated with a mixture of the fluorescent pigment and polystyrene Q-Dope, a low loss coil coating manufactured by GC Electronics. When dried, this even coating resisted any effects of temperature cycling from 77 K to ambient temperature.

The assembled cell was placed in a gas bath cryostat,[2] cooled to 100 K, and pressurized to 25 $MN \cdot m^{-2}$ with a helium–nitrogen mixture. With all components (except the front surfaced aluminum mirror and the flint glass) functioning, the level of the liquid mixture in the cell was raised and lowered by admitting more gas and draining the liquid, respectively. The meniscus appeared as a distinct group of black and white bands on the monitor. The contrast at the interface was excellent. Any changes in the meniscus were easily followed.

Several combinations of lens extensions were tried with the resulting changes in image magnification. The best results were achieved with an extension of 40 mm which yielded an image magnification of approximately 21×. The illumination of the cell interior was sufficiently intense to permit closing the lens aperture several stops.

No difficulties are expected to result from increasing the pressure to 70 $MN \cdot m^{-2}$ and lowering the temperature to 20 K. The effect of pressure on the luminescent efficiency should be negligible[3]. The reduced temperature might narrow the emission peak and increase the output, approaching a maximum near absolute zero.[4]

[1] Mention of specific products is for identification only and does not imply endorsement by the Bureau of Mines.
[2] W. E. DeVaney, L. Rhodes, and P. C. Tully, Cryog. Technol. **7**, No. 1 (1971).
[3] H. W. Leverenz, *An Introduction to Luminescence of Solids* (Dover, New York, 1968), p. 152.
[4] Ref. 3, pp. 136–46.

Reprinted from THE REVIEW OF SCIENTIFIC INSTRUMENTS, Vol. 41, No. 10, 1408–1409, October 1970
Printed in U. S. A.

A Fluorescent Backlighting System for Observing High Pressure, Low Temperature Phase Equilibria Phenomena

MARK R. ENSIGN AND PHILIP C. TULLY
Helium Research Center, Bureau of Mines, U. S. Department of the Interior, Amarillo, Texas 79106

(Received 13 April 1970; and in final form, 25 May 1970)

An electro-optical system for observing high pressure, low temperature phase equilibria phenomena has been tested at 25 $MN \cdot m^{-2}$ and liquid nitrogen temperatures. The system consists of a uv source exciting an intracell fluorescent pigment which illuminates the cell interior. The cell is observed by a closed circuit television camera and monitor, and a permanent record is made with a video tape recorder.

INTRODUCTION

SEVERAL interesting critical phenomena have been observed in our low temperature phase equilibria laboratory without a permanent record being made. To prevent this happening in the future, a system consisting of a closed circuit television (CCTV) camera, monitor, and video tape recorder (VTR) was purchased.

Two problems prevented the effective use of the system as purchased. The first was the absence of an adequate means of illuminating the cell interior. The second was an inadequate image size of the cell interior and its contents on the monitor because only a 1:1 image-to-object size ratio was achieveable. This provided only a 1×4 cm image of the cell window on the CCTV monitor.

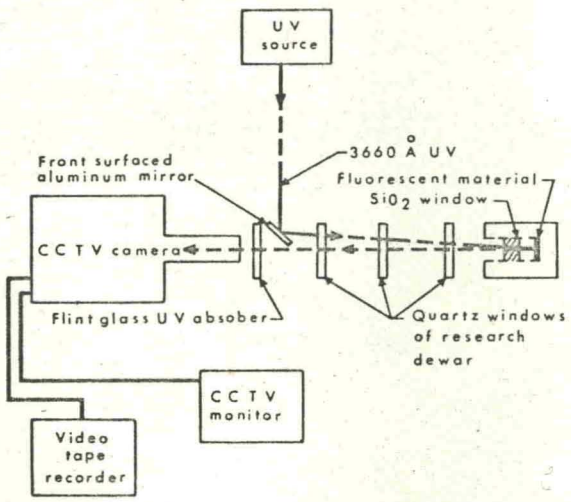

FIG. 1. Electro-optical system (schematic).

THE SYSTEM

The system for observing high pressure, low temperature phase equilibria phenomena consists of the following major components: a Sylvania model 600 CCTV camera[1] equipped with a Sylvania 25 mm, $f/1.9$ lens, and a Meyer Trioplan 90 mm, $f/3$ lens; a Sylvania model VMR 14 CCTV monitor with a 30.5 cm diagonal screen; a Sony Videocorder, model SV 300; and a blacklight Eastern Spectroline model B-100 uv source equipped with a spot bulb producing a 6.5° beam.

The schematic diagram of the system is shown in Fig. 1. From the uv source, a filtered beam of 3660 Å light is reflected from a front surfaced aluminum mirror into the cell interior. The rear of the cell chamber is coated with a fluorescent pigment, supplied by United States Radium Corporation, color No. 2205, which is excited by the 3660 Å ultraviolet and emits in the blue region with its emission peak at approximately 4500 Å. This peak corresponds to the spectral sensitivity peak of the Sylvania 1319 (RCA 7038) vidicon tube in the CCTV camera, thereby providing maximum image brightness.

The emitting fluorescent pigment provides a backlighting illumination that yields excellent image contrast of the vapor–liquid meniscus. The emission of the fluorescent pigment and the image of the meniscus then pass through fused silica cell window, the quartz Dewar windows, and a piece of flint glass, which absorbs any stray uv light, and into the lens-CCTV camera complex.

The Meyer Trioplan 90 mm $f/3$ lens is used in combination with a set of 1–80 mm variable lens extension rings. This feature provides the desired image magnification up to approximately 30 times, permitting as little as one fourth

of the cell interior to be enlarged to fill the entire monitor screen.

The electronic signal generated by the CCTV camera is generally fed to the video tape recorder, and from it another signal is passed on to the CCTV monitor. This provides a check on what is actually being recorded.

TESTING THE SYSTEM

A phase equilibria cell with a 1×4 cm rectanglar window was used. Before assembly, the rear of the cell interior was coated with a mixture of the fluorescent pigment and polystyrene Q-Dope, a low loss coil coating manufactured by GC Electronics. When dried, this even coating resisted any effects of temperature cycling from 77 K to ambient temperature.

The assembled cell was placed in a gas bath cryostat,[2] cooled to 100 K, and pressurized to 25 $MN \cdot m^{-2}$ with a helium–nitrogen mixture. With all components (except the front surfaced aluminum mirror and the flint glass) functioning, the level of the liquid mixture in the cell was raised and lowered by admitting more gas and draining the liquid, respectively. The meniscus appeared as a distinct group of black and white bands on the monitor. The contrast at the interface was excellent. Any changes in the meniscus were easily followed.

Several combinations of lens extensions were tried with the resulting changes in image magnification. The best results were achieved with an extension of 40 mm which yielded an image magnification of approximately 21×. The illumination of the cell interior was sufficiently intense to permit closing the lens aperture several stops.

No difficulties are expected to result from increasing the pressure to 70 $MN \cdot m^{-2}$ and lowering the temperature to 20 K. The effect of pressure on the luminescent efficiency should be negligible[3]. The reduced temperature might narrow the emission peak and increase the output, approaching a maximum near absolute zero.[4]

[1] Mention of specific products is for identification only and does not imply endorsement by the Bureau of Mines.
[2] W. E. DeVaney, L. Rhodes, and P. C. Tully, Cryog. Technol. 7, No. 1 (1971).
[3] H. W. Leverenz, *An Introduction to Luminescence of Solids* (Dover, New York, 1968), p. 152.
[4] Ref. 3, pp. 136–46.