NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

PROGRESS REPORT FOR PERIOD 12-1-61 to 5-1-62

Title: Influence of Gravity on Unicellular Organisms

The University of Texas Southwestern Medical School, Department of Pathology

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Evaluation of Ultraviolet Optics

A program of evaluation of various types of ultraviolet transmitting optics has been initiated to determine their suitability for use in flying spot scanning systems. The following objectives have been considered:

(1) Zeiss ultra-fluar 0.85 N.A., 100X
(2) Polaroid grey reflecting refracting objective 0.72 N.A., 53X
(3) Beck-Reflecting objectives
    0.28 N.A., 15X; 0.9 N.A., 172X
(4) Cooke, Troughton and Simms
    Quarts monochromatic objectives connected to 253 mu and 275 mu
    1.25 N.A., 81X; 0.70 N.A., 27X

The Zeiss ultra-fluar objective is an excellent objective, but its transmission and interface scatter losses appear to be in excess of similar losses in the Polaroid grey objective. In conventional ultraviolet microscopy these losses would not normally be considered significant. At the low ultraviolet light levels obtainable from currently available U.V. scanner tubes these two objectives appear to be comparable in their performance.

The low power Beck reflecting objective (0.28 N.A., 15X) must be considered separately from the two preceding objectives because of its very low numerical aperture and long working distance. For studies involving visualization of large numbers of cells this objective is extremely useful. On two of these objectives the silicon protective coating of the small mirror has deteriorated very rapidly due to unknown cause.

Beck 0.9 N.A., 172X

This is a water immersion objective. Its performance is adequate but the problem of maintaining the required water immersion seal at incubator temperatures of 37.5° C. is a serious limitation of its usefulness.

The Cooke, Troughton and Simms quartz monochromatic objectives are excellent but their narrow spectral band requirements prohibit their use in this application. Ultraviolet interference filters presently available do not restrict the band width to that required by these monochromats. Further, the low transmission of these filters introduces an intolerable loss of U.V. light.

Many of the objections mentioned here may be overcome by the development of U.V. emitting phosphors with greater efficiency and with narrower spectral band widths.

II. Ultraviolet Emitting Phosphors

We have received several samples of experimental ultraviolet emitting phosphors from Derby Luminescents Ltd. and the Rauland Corporation of Chicago. These phosphors have been deposited onto the face plates of cathode ray tubes by the Rauland Corporation. These tubes and phosphors have then been evaluated in this laboratory. This evaluation has consisted of a determination of the spectral characteristics, efficiency, stability and the durability of the phosphors. To date we have not found a phosphor which is superior to beryllium metasilicate. This program will continue and as a part of it Mr. William A. Bonner, the senior engineer of the project, will visit Messrs. Derby Luminescents, Ferranti, Cintel and EMI all of London, England. The purpose of these visits will be to discuss cathode ray tubes, ultraviolet emitting phosphors and ultraviolet sensitive multiplier photo tubes.

III. Display Tube

We have investigated a variety of phosphors as applied to display tubes and have concluded that for our purposes the best results are achieved by the use of a long persistence P-19 phosphor.

IV. Optimization of Sweep Techniques

We have given careful consideration to the various fixed sweep speeds available to us. This study has led to the conclusion that no single set of vertical and horizontal sweep speeds can lead to the efficient collection of specimen information. One way of overcoming this deficiency would be the use of velocity modulated sweep techniques. Such techniques present severe calibration and synchronization problems. Consideration of various alternative scanning methods has led to the evolution of a new system of scanning microscopy. This system will be described in detail in the annual progress report. In brief the system functions as follows:

The focused spot on the scanner tube face remains stationary at any given picture point until a pre-designated amount of information is collected. At this time the scanning beam is moved rapidly to the next point, where the process is repeated. Information collection is achieved by means of a linear integrator circuit. This integrator is discharged during the spot movement. It will be seen that the spot rest time is a function of image information content. An inverse process is utilized to display the information in a form suitable for photography. The scanning principles described are not restricted to ultraviolet microscopy but have a general applicability.

Calculations indicate that this system is capable of yielding extremely high signal to noise ratios. A simple preliminary apparatus has been constructed which will analyze only 100,000 picture points in the microscopic field. This will be regarded as an exploratory system for the evaluation of the electronic performance.