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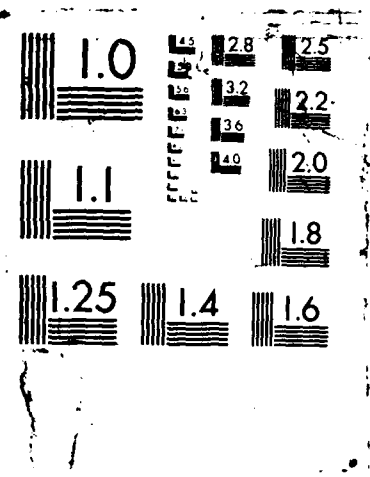
APPLICATIONS RESEARCH STUDIES OF MICROTUBULES(U) HUGHES 1/1
RESEARCH LABS MALIBU CA EXPLORATORIES STUDIES DEPT
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Contract No. N00014-87-C-2354



RESEARCH LABORATORIES

(Competitive Award: \$525,603.00)

APPLICATIONS RESEARCH STUDIES OF MICROTUBULES

Monthly Letter Progress Report #3

Period: 12 October 1987 to 13 November 1987

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1. General Objectives and Approach

This contract provides the Hughes Research Laboratories (HRL) funding for the first year of a three year research program to investigate techniques basic to novel applications of lipid microtubules for electro-optical, optical, and sensor devices, and to study the feasibility of such device applications. The overall program has two main area: (1) The study of ordered microtubules in fluids and films, for applications such as variable transmission windows, IR polarizers, and dichroic filters; (2) The study of ordered attachment of microtubules to surfaces, for applications such as nonlinear optical devices and acoustic detectors. The emphasis in this first year is on the suspension, orientation and electro-optical properties of microtubules in fluids, liquid crystals, and polymers, and on techniques for controlling the orientation and attachment of microtubules to surfaces.

2. Work In The Third Month

Both flow alignment and electrical field alignment (parallel to the field) were observed with dilute dispersions of NRL Cu-coated tubules either in a liquid crystal (BDH-E7, which has $\Delta\epsilon > 0$) or in an optical cement (Norland NOA-65). In parallel plate conductive glass cells, alignment in LCs was observed with about 10V across 50 μ m and there was a slow return to the initial surface-parallel alignment upon removal of the field. Tubules in similar cells with the optical cement were oriented with 35V, with only partial return with the field off. A better view of the electrical orientation was observed by polymerizing the optical cement while a lateral field was applied, as shown in the attached figure. Voltage was applied between two metal electrode shims sandwiched between glass slides, and thus also serving as the cell spacer. [A viewgraph will be sent separately.]

So far we have not been able to align dispersions the NRL Ni-coated tubules in either magnetic or electrical fields. The samples provided to us were in water filled vials, and we believe that virtually all of the nickel has been oxidized.

3. Plans For Next Month

We plan to continue studies of metal-coated microtubules dispersed in fluids. Liquid crystal hosts of positive, negative, and cross-over dielectric anisotropy will be compared with the isotropic state in order to distinguish electrical orientation effects by the fluids versus field



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orientation of the tubules themselves. Preliminary optical switching studies will be made with higher concentrations of tubules. Polymerizable hosts will be studied and electrically field aligned in fixed patterns. We will also examine the preparation of tubules aligned in polymer dispersed liquid crystals. We plan to begin the preparation of grooved surfaces, prepared via holographic exposures, for surface alignment studies of microtubules.

4. Project Status

Funds expended through this period were about \$19.3K at the manufacturing level (corresponding to about \$25.1K sales level). This is temporarily below budget plans due to delays in scheduling work on holographic exposures and due to participation by several of us at an out of town program review on another project. At the end of this period, we received from NRL some bulk lipid material with which to study the controlled aligned growth of microtubules. We need to obtain some fresh (dry) Ni-coated tubules as soon as possible.

APPLICATIONS OF MICROTUBULES --ELECTRICAL FIELD ALIGNMENT

HUGHES

LATERAL FIELD ALIGNMENT OF METAL-COATED TUBULES

Cu-Coated Tubules

Dispersed In Optical Cement

Photopolymerized With Field On

Cross-Section View

Between Glass With 50 μ m Spacing

Metal Electrodes 0.75 mm Apart \uparrow
60V, rms Applied (800V/cm).....Field

Vertical Field Direction \downarrow

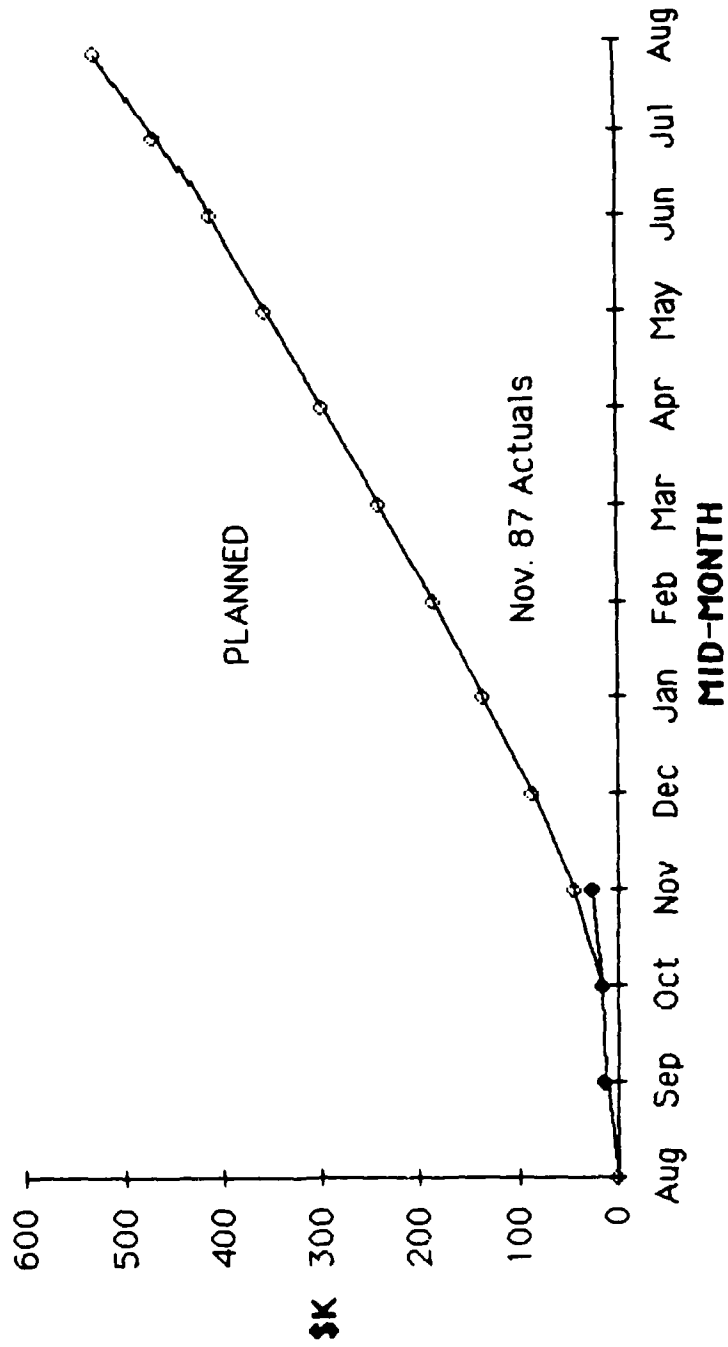
Cell Filled Horizontal Direction

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Metal Electrode \Rightarrow
Fill Direction \Rightarrow

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