EES NOTES

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In This Issue:

WELCOME TO DEAN STELSON

Thomas E. Stelson will become Dean of the College of Engineering on January 1, 1971. He has been head of the Department of Civil Engineering at Carnegie-Mellon University since 1957 and co-director of the Transportation Research Institute since 1966. In 1967, the American Society of Civil Engineers named Dr. Stelson "Pittsburgh's Young Civil Engineer of the Year."

PROTEIN SYNTHESIS IN IRRADIATED FOOD POISONING MICROORGANISMS

There is understandable interest and concern among all individuals in matters that relate to the health of the general public. In those industries responsible for commercial production of foods to be marketed for consumption, this concern is manifested in their efforts to: (1) rid such food products of potential disease-causing microorganisms, and (2) not produce any toxic chemical by-products in the food material as a result of their processing techniques.

Of the microorganisms found as natural contaminants of foods that can cause human disease, the most resistant to chemical and physical treatment is a bacterium called Clostridium botulinum. Its resistance is due to the production by the cells of this organism of spores, a cell form that is protected from external influences by very thick shells of coat material. The cells of this bacterium grow and reproduce in the absence of oxygen -- the condition that exists in "vacuum packed" foods whether they are in cans, in plastic pouches, or in jars. As a by-product of its growth, this organism can produce a highly poisonous substance that acts as a neurotoxin when ingested by man, causing a food poisoning condition known as "botulism." The disease has a mortality rate ranging from 10% to 90%, depending upon the strain of microorganism involved.

The majority of botulism outbreaks in the past have been due to inadequate heat processing of home-canned food by housewives. Storage of the food gives the spores of the botulism organism time to germinate. When it is opened later, the cells that have grown have produced the toxin which is fatal to individuals who then eat this food. Since the toxin is a protein, it can be destroyed by heating at boiling temperature for ten minutes, which accounts for the relative infrequency of botulism outbreaks.

With the introduction of new methods of processing, packaging, and distributing foods and the resulting increase in length of their "shelf life," the factors of microbial contamination and chemical alteration of the food products must constantly be re-evaluated. Use of ionizing radiation as a new process for "cold sterilization" of foods to replace or supplement conventional heat processing has been a hope of government agencies as one possible peacetime use of radioactive materials by commercial food producers. The usual radioactive materials used have been cobalt-60 and cesium-137, which emit gamma rays of specific energy: 1.17 and 1.33 Mev for cobalt-60 and 0.662 Mev for cesium-137. The effect of ionizing radiations on microorganisms present in foods and on the chemical structure of the food itself, however, must be fully understood and controlled before the Food and Drug Administration will permit release of foods so processed to the commercial market.

In an effort to control its appearance in irradiated foods, work is presently being performed to determine how the botulism toxin -- a protein -- is produced by Clostridium botulinum after gamma irradiation of the organism. The spores are subjected to doses of gamma rays ranging from 100,000 rads to 1,750,000 rads and then transferred to a medium in which they can germinate, grow, and produce new cells. The cells that grow after irradiation are studied to determine changes in their patterns of growth and toxin production as a function of the temperature of post-irradiation incubation and the strain of the microorganism being studied.

Plans for the future include studies on cells which have been broken open under high pressures at certain stages in their life cycle. Certain sub-cellular components known to be associated with protein synthesis will be extracted, purified, and chemically analyzed in an effort to understand protein synthesis mechanisms, not only as an aid in controlling this organism but also because this information is applicable to all living cells. Bacteria are useful test systems for studying such life processes because they reproduce very rapidly (as fast as once every 20 minutes) and produce large amounts of material within a 24-hour period; as a consequence, they give the investigator a large quantity of cells with which to do his experiments.

N. W. Walls
Nuclear and Biological Sciences Division

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SOUTHEASTERN FORGING MARKET STUDY

Forging may be defined as the process of giving metal increased utility by shaping it, refining its grain, and improving its mechanical properties through controlled plastic deformation under impact or pressure, usually at high temperatures. Forgings are commonly found in machines and conveyances at critical points of shock or stress -- particularly where reliability and human safety are affected.

In 1969, a survey was conducted by the Industrial Development Division to determine the size of the forging market in a six-state area in the Southeast -- Georgia and its five neighboring states. Questionnaires were sent to 1,854 metal-working companies in the six states and responses to the survey totaled 1,067, a 58% return. The utilization of forgings in the six-state area was estimated at $46 million in 1969, and annual growth was estimated at $4.6 million or about 10% a year. Of the total forgings purchased, carbon steel constituted $19 million, alloy steel $16 million, and nonferrous $11 million. Closed impression die forgings comprised about 66% of the total and open die forgings about 34%. Captive supplies were estimated at $8 million or about 17% of the total forgings used in the area. Annual consumption of forgings plus their competing materials (castings, weldments, etc.) was estimated at $131 million; 35% of the total is forged.

Major end users of forgings in the area are the manufacturers of fabricated plate work (boiler shops), aircraft parts and auxiliary equipment, metal stampings, and farm machinery and equipment. Purchased forgings in the area come largely from Ohio, California, Pennsylvania, Massachusetts, Indiana, Illinois, Tennessee, Alabama, and Michigan. Over one-fourth of the consuming companies would increase their forging purchases above their normal growth if a new forging plant were within easy reach.

According to the 1967 Census of Manufactures, the U. S. value of shipments of all forgings increased from $786 million in 1958 to $1,620 million in 1967, an annual growth of 8.4%. The market for forgings will continue to grow because of increasing demand for high-strength and stress-resistant parts for modern machines and vehicles. The value of shipments of all forgings is projected to reach $1,789.7 million in 1970 and $2,217.6 million in 1975.

Forging facilities in the United States are highly concentrated in Ohio, Illinois, Wisconsin, California, Texas, Pennsylvania, Massachusetts, and New York. Of nearly 400 commercial forgers in the nation, only nine small ones are located in the six-state Southeast. Historically, growth of the forging industry has paralleled the general industrial expansion. In the last decade, the metalworking industries in the six states have grown at a rate three times that of the nation, and the market for forgings should rise at least as rapidly as the growth of the metalworking industries in the area.

The rapidly growing metalworking complex in the Southeast consumes a much larger volume of forgings than it produces, and Georgia's central position in the area makes it an excellent location for new forging facilities to help bridge the widening gap between supply and demand. A new forging plant locating in Georgia will enjoy such major advantages as close coordination with potential customers in the area, shorter delivery time, freight savings, lower labor cost, and wider choice in plant location.

Tze I. Chiang
Industrial Development Division

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TRANSIENT HEAT CONDUCTION

Much attention has been given in recent years to the numerical solution of the partial differential equation of heat conduction in solids with temperature-dependent properties and with time-dependent boundary conditions. Only recently, however, has attention been focused on that class of materials with properties dependent on time as well as temperature. One such material of current interest for very high temperature applications is slip-cast fused silica (SCFS). Because of the nature of the fabrication process used in its production, SCFS has a density of about 80% of that of fused quartz. At temperatures below 2200°F, densification is extremely slow and thus may be neglected in the heat conduction analysis of common engineering problems. As the temperature is increased above 2200°F, the densification rate increases rapidly, and thus the density becomes a function of time as well as temperature. In addition, the thermal conductivity is a function of density and temperature, so it too becomes dependent on time and temperature above 2200°F.

A computer program has recently been developed at the High Temperature Materials Division which generates solutions for the numerical, one-dimensional, transient heat conduction equation as it relates to SCFS. Specifically this includes time and temperature-dependent densification and thermal conductivity. Primarily this computer program was developed to predict temperature profiles in SCFS slabs subjected to a severe thermal environment on one surface. These profiles are required for the fulfillment of research to determine the dielectric constant and loss tangent data at temperatures up to 4000°F. The densification expression used in this analysis is semi-empirical, and constants were obtained from experimental work accomplished earlier by Division personnel. The required input data for the computer program are experimentally measured time-dependent surface temperatures.

In addition to the primary purpose, the new thermal analysis program will permit determination of the thermal conductivity of SCFS as a function of density and temperature well above the softening point of the material. This objective will be accomplished by comparing predicted temperature profiles with data from embedded thermocouples and adjusting the constants in the proposed thermal conductivity relationship in the thermal analysis program to give the "best fit" over the range of available data. At present no reliable data exist for SCFS above 3000°F. This new indirect method is expected to provide data to temperatures above 4000°F.

It also should be mentioned that this thermal analysis program is not restricted to SCFS. If the properties of other materials were sufficiently well known to permit arrangement into the mathematical representations required by the computer program, temperature profiles could be obtained for these particular materials with only slight modification to the existing program. With this concept in mind, predictions are to be made in future work for boron nitride.

C. S. Gorton and A. C. Merritt
High Temperature Materials Division

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TRANSDUCER RESEARCH

A new prototype electro-mechanical transducer has been developed for cardiovascular applications. The sensing element is mounted in the tip of a catheter for the measurement of intravascular pressures and sounds, including those of the heart.

The transducer consists of a transistor which is mechanically stressed by a small hard needle of which the hemispherical tip is bonded to the transistor surface. The opposite end of the needle is in contact with a thin metal diaphragm which receives the mechanical and acoustic impulses. Force exerted on the transistor by the needle results in the modulation of the current flowing in the transistor; the amount of current change is nearly a linear function of the mechanical input. The transducer, 2 mm in diameter and 1 cm in length, is mounted in the tip of a catheter with a 2.75-mm outside diameter and approximately 120 cm long. Electrical connections to the transducer are brought out through the catheter by means of a small, flexible, three-conductor shielded cable. Pressure and sound information are obtained simultaneously by the corresponding electrical filtering of selective frequency bands. Data have been obtained with several of these transducers in the left ventricle and the aorta of a number of dogs. The best results to date have been obtained with catheters of woven dacron.

An unusual property of these transducers is their high voltage sensitivity, one hundred to one thousand times that of commercially available semiconductor strain gage devices. Comparative data obtained with currently used transducers show that the devices are capable of giving high fidelity recordings over a wide range of frequencies.

Paralleling these developments in transducer construction, considerable progress has been made in the design of circuitry for proper biasing of these devices and in signal processing. This work includes the design of an active temperature compensation system using analog computer techniques and a study of methods for correcting possible changes in sensitivity with temperature and for making linearity corrections.

Current research is directed toward simplifying fabrication techniques and further reducing the device size for diagnostic uses in humans, especially children.

Robert A. Newsom
Physical Sciences Division

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SOLID-STATE RADAR

The external appearance and the internal makeup of radar systems have undergone many changes over the past three decades. Early World War II radars, while functionally effective, were simple in comparison with many of our modern radar systems. Of several reasons for such changes, one is that new components have been developed for performing some required functions. For example, transistors have replaced vacuum tubes in the intermediate frequency and video amplifiers of many radar receivers. Another reason for the evolution of radar systems is the increased number and complexity of tasks assigned to radar.

A radar which can perform a number of different tasks may be described as a multifunction radar. Such a radar, for example, might be capable of searching a large volume of space and detecting the appearance of any objects of interest while at the same time providing the trajectory and the present location of all objects within that volume. This multifunction radar capability is desirable in such applications as civilian air traffic control as well as for various military purposes.

As a result of the demand for radars with more and more multifunction capabilities for performing difficult tasks, the design, construction, and operation of radar systems are becoming extremely complex. This increased complexity has led to radars having increased development and construction costs, greater size and weight, and, in many cases, decreased reliability with significant burdens of maintenance and operation. Consequently, any available means for the realization of a reliable, compact, multifunction radar is of considerable interest for several important applications.

Since May 1968, we have assisted the Air Force Avionics Laboratory in evaluating the applicability of molecular electronic devices to a multifunction phased-array radar for airborne application. The envisioned radar would be completely solid state, including solid-state devices for microwave power generation, and would incorporate integrated circuits in the microwave frequency region. Since operation of a multifunction phased-array radar requires computer control, application of digital computer technology would be significant in realizing the full potential of the system. Specific objectives of the study program include (1) determination of the state-of-the-art of applicable solid-state devices and microwave integrated circuit techniques; (2) projection of state-of-the-art performance to approximately five years in the future; (3) recommendations on the utilization of solid-state devices and microwave integrated circuits which are based on their present, projected, and fundamental capabilities; and (4) determination of the radar capability which would be achievable with various combinations of devices at different time periods.

Our studies have shown that completely solid-state radars with true multi-function capability and good reliability should be achievable by about 1975. Further work is needed to define the cost-effectiveness of solid-state radars versus conventional radars as a function of several parameters, including (1) the time when construction is begun, (2) the desired radar capability, and (3) the specific radar application (e.g., air traffic control or airborne) which would affect such choices as the importance of size and weight and the number of radars constructed.

Dayton Adams
Electronics Division

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PROFESSIONAL ACTIVITIES

Papers and Presentations

J. L. Brown, PSD, and J. L. Hubbard, PSD, attended the 28th Annual Meeting of the Electron Microscopy Society of America in Houston, Texas, October 5-8. Brown gave an invited paper, "Applications of Transmission and Scanning Electron Microscopy to Materials Science," and Hubbard presented a contributed paper, "A Comparison of TEM and SEM Fractography." Both papers were published in Proceedings, Twenty-Eighth Annual Meeting, Electron Microscopy Society of America, edited by C. J. Arceneaux, Claitors Publishing Division, Baton Rouge, Louisiana, 1970.

A contributed paper, "Chlorite Examination Ultramicrotomy and High Resolution Electron Microscopy," by J. L. Brown, PSD, and M. L. Jackson, University of Wisconsin, was presented at the 19th Annual Clay Minerals Conference, October 12-17, in Miami, Florida.

John H. Burson, CSMD, gave talks on "Industrial Emission Control" at Air Pollution Control Workshops for Georgia industry conducted by EES and the Georgia Department of Public Health in Albany on August 26, in Augusta on September 23, and in Savannah on October 21.

At the Middle Flint Area Community Industrial Development Seminar held in Americus, Georgia, on December 16, Ross W. Hammond, IDD, spoke on "The Importance of Industrial Development" and David C. Morgan, IDD, spoke on "Basic Data for Industrial Development."

John E. Husted, CSMD, moderated a panel discussion at an Aluminum/Alumina Symposium held in Atlanta on September 17; the off-the-record meeting of researchers and government representatives was sponsored by Georgia Tech and the Georgia Department of Industry and Trade to discuss use of the state's kaolin deposits.

J. W. Johnson, PSD, read a contributed paper, "An Investigation of Filler Distribution in Paper and Rubber Samples by Electron Probe Microanalysis," at a meeting of the Society for Applied Spectroscopy in New Orleans, Louisiana, October 5-10.

R. W. Moss, ED, and H. H. Jenkins, ED, were coauthors with W. S. Hayden, U. S. Army Security Agency, of a paper entitled "Application of Synchronous and Correlation Detection to HF/DF Systems" presented by Hayden at the Radiolocation Conference in Sydney, Australia, November 9.

At the Second Particle Size Analysis Conference, Bradford, England, Spetember 9-11, Clyde Orr, CSMD, presented a paper on "Automatic Sedimentation Size Analysis Instrument."

C. O. Pollard, PSD, presented a paper on "Dioctohedral Phyllosilicates: Interlayer and Interlayer Rotations" on October 14 at the Annual Clay Minerals Conference, Miami, Florida.

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Publications

G. L. Bridger, CSMD, "Fertilizer Technology in the 70's," Fertilizer Progress, September-October, 1970.

J. D. Clement, NBSD, and J. R. Williams, NBSD, "Gas-Core Reactor Technology," Reactor Technology, Vol. 13, No. 3, Summer 1970, 226 ff.

Robert H. Fetner, NBSD, "A Comparison of Radiation-Induced Reproduction Death and Chromosome Exchanges in Chinese Hamster Cells at Room Temperature and in Liquid Nitrogen," Int. J. Radiat. Biol., 1970, Vol. 17, No. 5, 467-478.

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Elections and Distinctions

Ross W. Hammond, IDD, is listed in the 1970 edition of Engineers of Distinction, published by the Engineers Joint Council.

John E. Husted, CSMD, is on the Editorial Advisory Board of the Mining Engineering Handbook of the Society of Mining Engineers. He also has completed all requirements for his Ph.D. at Florida State University.

In October, Raymond D. Kimbrough, Jr., NBSD, was reelected secretary of the Georgia Section of the American Chemical Society for 1971-72. He also is associate editor of the Section's Filter Press. In addition, Dr. Kimbrough is a councilor of the Georgia Academy of Science, having been elected from the Chemical Divison for the 1970-72 term.

At the Annual Conference of the Southern Industrial Development Council in Baltimore, Maryland, October 25-27, George I. Whitlatch, IDD, was awarded a plaque honoring his efforts as one of four founders of SIDC.

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Abou Award

Each December, "Abou," EES's own plaster bust of an Arabian chieftain, is passed on to the person who, through no fault of his own, has suffered most in the cause of research. This year's recipient is Nelson C. Wall, Head of IDD's International Development Branch, who suffered on two continents and in three languages, undergoing untold hardships for more than five months in Venezuela, Paraguay, and Brazil.

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SUBMISSION OF ARTICLES

Contributors in the divisions should submit their articles to the appropriate division coordinator listed below. Others may send their contributions via campus mail to Martha Ann Deadmore at the Industrial Development Division.

Division Coordinators

Chemical Sciences and Materials Division	Walter H. Burrows
Electronics Division	H. A. Corriher, Jr.
High Temperature Materials Division	Nick E. Poulos
Industrial Development Division	Martha Ann Deadmore
Nuclear and Biological Sciences Division	Geoffrey G. Eichholz
Physical Sciences Division	Robert L. Bullock