Fall 1996 Meeting Abstracts

THE FUNCTIONAL STRUCTURE OF THE COTTON FIBER

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Cotton is a unique textile fiber because of the inter-relationships of its structural units. From its multi-component primary wall, through the pure cellulose secondary wall, to the lumen, the organization of subfiber units provides the fiber with characteristic properties that make it a processable, strong, comfortable textile fiber. The fiber is a single biological cell that initiates on the surface of the cotton seed at anthesis. The cell wall that develops for 16-20 days becomes the primary wall or "skin" of the fiber. It is a network of cellulose fibrils in which noncellulose materials are intermeshed. Completion of the primary wall development is overlapped by beginning secondary wall synthesis, the process of deposition layers of cellulose microfibrils inside the primary wall. These layers produce the main body of the fiber. Complete development of this secondary layering process is essential to the production of mature fibers. If growth is interrupted at any point before completion of the secondary wall, immature fibers result. While microfibrils in the primary wall of the fiber are not oriented in an orderly fashion, those in the secondary wall are deposited parallel and in a spiral around the fiber axis. These fibrils are bound to each other by hydrogen bonds and are susceptible to disruption when not protected by the primary wall. The fibers develop in the constricted compartment of the boll locule. Opening of the boll causes drying and fluffing of the fibers. As moisture is removed, compression causes the twisting and flattening that produces the typical cotton fiber.

COTTON FIBER SELECTION & BLENDING: CONCEPTS, ALGORITHMS, AND APPLICATIONS

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In recent years, a great deal of development in the area of fiber testing and fiber

information technology has been achieved. This development has resulted in improving our knowledge about the role of cotton fiber quality in processing performance and end product quality. More importantly, the implementation of fiber-to-fabric engineering concepts in manufacturing cotton textiles has become a possibility. One of the crucial issues in this regard is cotton fiber selection and blending. This study focused on three main subjects: (a) the concepts underlying cotton fiber selection and blending, (b) the algorithms developed for optimum fiber selection, and (c) practical applications.

It will be interesting to note that the process of blending different components of cotton fibers represents the ultimate complexity of mixing various components of fibers. A special case of this situation will be the blending of cotton with synthetic fibers, typically known as the two-component blend. This study will provide several guidelines that can be useful for natural/synthetic blends.

APPLICATIONS OF ARTIFICIAL NEURAL NETWORK ON TEXTILE RESEARCH

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Artificial neural network is an analytical system that addresses problems whose solutions have not been explicitly formulated. In this paper, we briefly introduce the algorithm of neural network. We also applied this technique in following two studies: 1) We built a prediction model that used neural network. It can predict the yarn properties based on the inputs of fiber properties. 2) We then built a neural network classification model. It can classify a fabric hand based on the inputs of fabric properties. Both models gave very good results. The studies showed that neural networks provide a new approach to understand the complex cause-effect relationships.

OVERVIEW OF KENAF PROCESSING AND TEXTILE PRODUCT DEVELOPMENT

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Mechanically processed kenaf bast fibers are being used for grass and erosion mats which have been successfully commercialized (Fisher, 1994). Other products made of kenaf core, such as, oil sorbents, insulation panels, animal bedding and potting media (Chen et al., 1995) are being distributed in the market place. Bast and leaf fiber research has produced strong and lustrous fibers for various products, ranging from the sophisticated flax to abaca fibers used in car seat belts (Srinathan et al., 1990; Estilo et al., 1980). Research done in our laboratory has demonstrated that good textile quality fibers can be extracted from kenaf bast (Ramaswamy et al, 1994a & 1995a). The feasibility of both woven and nonwoven textile products (Ramaswamy et al., 1995b & 1994b) made with kenaf fiber blends has also been demonstrated. Work done with hand spinning and weaving has resulted in rugs, placements and jacket weight fabrics (Ramaswamy, 1996).

However, for kenaf blend fabrics to be used in apparel and upholstery, it is essential to evaluate the response of kenaf/cotton fabric to various consumer end-use tests. Therefore, experimental and control fabrics were compared for the following properties: a) Threadcount, b) Thickness, c) Weight, d) Strength and Elongation, e) Dimensional stability, f) Wrinkle Recovery, g) Abrasion Resistance, h) Tear Strength , i) Staining and Stain Release, and j) Pilling Resistance. The properties measured were also compared with performance specifications of the following products: a) awning and canopy fabrics, b) upholstery fabrics, and c) shop coat fabrics.

The results indicate that the experimental and control fabrics did not significantly differ in threadcount, weight or thickness. Breaking Strength and elongation and abrasion resistance were not significantly different for the experimental and control fabrics. The tear strength of experimental fabrics passed the requirements for the target end products, however, compared to cotton controls (in both warp and weft) tear strength was lower. Wrinkle recovery for both fabrics was the same and it did improve with time. Shrinkage was identical in warp (11%) and the weft (34%) directions. There was no significant difference in the stiffness of the two fabrics and this may be due to carding step where kenaf fibers were carded to resemble the cotton fibers**.** Experimental fabrics with kenaf fibers passed all performance specifications for canopy, upholstery and coat fabrics. In addition to the physical properties measured, kenaf also brings an exciting texture and luster to the fabrics.

INSIGHTS INTO THE TRANSFORMATION OF WOOLEN FABRIC IN FULLING AND NAPPING

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Woven fabric taken directly from the loom has a hard, reedy texture. It requires great care and attention to convert it to the desired finished fabric, which is typically soft and lustrous. Felting shrinkage takes place in fulling, the first and most critical operation in finishing. We will discuss the process of hand fulling Harris Tweed from the outer Hebrids beginning a century ago and proceeding to the new state-of-the art equipment. Future developments in fulling are in the area of open width fulling.

By the time it is ready for napping, cloth is usually irregular in appearance. The surface of the cloth is uneven and shaggy because of protruding fibers. Napping, or raising, is accomplished by passing the cloth in a tightly stretched condition over a revolving cylinder, or roller, covered with metal wire. Napping is performed on fabric for several reasons, such as: to entrap air thereby reducing thermal conductivity, to give more body, to make the fabric feel softer or smoother in hand, for durability, for improved cover, to add to the selling points of the fabric, and to cover minor defects and blemishes. Napping can "make" the fabric. Future developments in napping are in the areas of reducing tension to increase the fraction of fabric surface in contact with the raising rollers, and electronic monitoring of tension between the fabric selvages.

ELECTROKINETIC PHENOMENA STUDIES ON SILK FIBRE

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The streaming potential method was used to study the electrokinetic phenomena of silk fibre under different pH conditions. Such phenomena include zeta potential (z), surface charge density (s) and the differential capacity of diffused part of the double layer of the fibre (C_p). As a protein fibre, the electrokinetic property of silk is closely related to the solution condition under which it is subjected. When the pH of solution is smaller than the isoelectric point of silk, the (z) and (s) are negative, otherwise they are positive. The C_p of silk fibre is always positive and it resembles a v-shape under the influence of pH or (z) and reaches a minimum at IEP.

ANALYSIS OF KNITTED FABRIC MODELS USING IMAGE PROCESSING AND GEOMETRIC MODELS

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For years knitting has been considered more of an art than a science. Many attempts have been made over the past century to quantify the characteristics of a knitted fabric. The key to unlocking a knitted structure lies within its basic element, the single knitted loop. It has been shown that the length of yarn knitted into a single loop will determine such overall fabric qualities as hand, wearer comfort, weight, extensibility, finished size, and cover factor. Therefore, to gain control over the characteristics of the final fabric, the single knitted loop must be controlled to meet certain criteria. The problem then arises of how to determine that a knitted loop is the correct size for a given set of fabric properties. The answer lies in the ability to measure the length of that loop. Once a loop in a fabric is measured, then loops of that size and fiber type can be correlated with the particular properties of that fabric. So how is the loop measured? Since 1914 when Ernest Tompkins first proposed equations for measuring a loop based on the cotton count, weight, wales per inch, and courses per inch, many people have attempted to derive both empirical and theoretical equations to more accurately describe the length of yarn knitted into a loop. With the advent of computers, and more specifically image processing, this age old problem of measuring a knitted loop has been solved. Now a loop can be characterized in a matter of seconds with great accuracy. Computers have not only provided an easy method for characterizing a loop, but they have also provided a means for checking past models to determine which equations and methods provide the most accurate description of a knitted loop. Scientists have used geometry, relationships determined through

experimentation, energy minimization, and neural networks to find knitted loop lengths. Using image processing to find the length of a loop and then comparing this value to past equations, allows a century's worth of work to be narrowed to the most accurate descriptions, and provides insight into what characteristics are important in determining loop length. This paper will discuss the merits of past knitted loop models by using image processing as a comparison, and determine which methods of loop characterization are the most beneficial.

THE ROLE OF FIBER ARCHITECTURE IN THE AIR FLOW RESISTANCE AND PERMEABILITY OF RENITENT COMPOSITES

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Sound abatement may be realized through the use of porous, rigid barriers. The performance of a material as a noise barrier can be correlated to its resistance to air flow at differing pressure drops. A *linear resistor* is a material for which resistance to flow is invariant with respect to pressure; a *nonlinear resistor* exhibits variable resistance. Current microporous liners are produced by etching metallic plates in a process which is wasteful and expensive. Rigidized textile structures are examined in this paper as cost-effective alternatives to the conventional systems. These *renitent composites* were formed by the localized encapsulation of filament yarns within a textile structure using epoxy resin. Resistance to air flow was measured and the linear air flow resistance factor determined.

Emphasizing a unit cell approach, a model is presented to predict the permeability of renitent composites. The Kozeny-Carman equation provides a relationship between porosity and permeability for a material. The role of air flow resistance and permeability in sound abatement is discussed. It is proposed that air flow resistance is a key in sound abatement performance, and measurement and interpretation of this data is outlined. Applications for renitent composites are discussed.

THE DYNAMICS OF FABRIC DRAPE

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Fabric deformation is modelled as a nonlinear dynamical system so that a fabric can be completely specified in terms of its mechanical behavior under general boundary conditions. Fabric deformation is dynamically analogous to waves travelling in a fluid. A localized two-dimensional deformation evolves through the fabric to form a three-dimensional drape or fold configuration. The nonlinear differential equations arising in the analysis of fabric deformation belong to the Klein-Gordon family of equations which becomes the sine-Gordon equation in three dimensions. The sine-Gordon equation has its

origins in the study of Backlund Transformations in differential geometry. Fabric deformation is described as a series of transformations of surfaces, defined in terms of curvature parameters using Gaussian representation of surfaces. By considering a deformed fabric as a two-dimensional surface, analytical solutions of fabric deformation are algebraically constructed by solving the sine-Gordon Equation. These analytical expressions describing the curvature parameters of a surface represent actual solutions of fabric dynamical systems.

NOVEL COMPOSITES BY HOT COMPACTION OF FIBRES

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The production of solid section products from highly oriented fibers by a novel compaction procedure is described for melt-spun and gel-spun polyethylene fibers, polyethylene terephthalate and polypropylene fibers and Vectran liquid crystalline copolyester fibers. Differential scanning calorimetry and electron microscopy have been used to study the structure of the compacted polymers. For the most successful compaction, selective surface melting of a small fraction of each fibre enables the formation of a fibre composite of high integrity, where the matrix phase is formed by epitaxial crystallization of the melted fraction on the initial fibers, retaining a very high proportion of their initial strength and stiffness.

A very wide range of potential applications is envisaged for the composites produced by hot compaction. In many cases these composites will be produced by thermoforming. In addition to the obvious advantages of high stiffness and strength, in several instances the unrestricted exploitation of unique properties of the fibers such as transparency to microwave radiation or very low thermal expansion coefficients offer additional incentives for the use of these hot compacted materials rather than conventional fibre/resin composites.

THE FORENSIC APPLICATION OF TEXTILE FIBER ANALYSIS: A SURVEY OF INTERESTING CASES

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Textile fibers are common forms of physical evidence recovered at crime scenes and on the clothing of individuals involved in crime. The identification of these fibers follows routine laboratory procedures that include the examination of visual microscopic characteristics, polarized light microscopy, microspectrophotometry and others. The weight placed on a particular fiber "match" is directly related to the forensic examiner's experience and available reference materials. Information provided by fiber manufacturers and fabric producers can assist in determining how much weight one can place on a fiber association. Several investigations are highlighted that demonstrate the significance of textile fiber analysis in a forensic laboratory.

A POISSON MODEL OF NONWOVENS IN COMPRESSION AT HIGH STRESS

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The stress/thickness relationship for an assembly of discrete, randomly-deposited fibers has been predicted from the fiber dimensions, density, and transverse compression modulus and the web weight only, without the need for arbitrary curve-fitting parameters. By treating web formation as a Poisson process, the distribution of fiber mass on the plane can be described probabilistically, and the total stress developed during compression of the fiber assembly can then be determined by summing forces that result from deformation of the statistical subunits of mass.

The model developed describes reasonably well the steady-state properties of needled nylon, KevlarÆ, and SpectraÆ nonwovens that have been repeatedly subjected to high levels of compressive stress. It also provides a way to examine the uniformity of pressure distribution during compression.

CONVERSION OF CARPET WASTE TO THERMOPLASTIC RESINS

Satish Kumar

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In 1995 approximately 8 billion lbs of carpet was produced in the United States, which consumed three billion lbs of nylon fiber. It is estimated that three to four billion lbs. of the new carpet production goes for replacing old carpets. Most of the used carpet currently goes to the landfills. Carpet is generally a four component system, with nylon as the face fiber, polypropylene as the primary and the secondary backing, SBR as the adhesive and calcium carbonate as filler. Various carpet recycling technologies will be discussed. Attempts to reclaim thermoplastic resins by compatibilization and recative extrusion will be presented.

CARPET WASTE FIBERS FOR SOIL REINFORCEMENT IN ROAD CONSTRUCTION

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About 4 billion pounds of post-consumer and industrial carpet waste is discarded into landfills each year nationally, accounting for about 1% of the total solid waste disposed

(fraction based volume is higher). Carpet waste is more difficult to handle in landfills and it has a very slow rate of decay. Many of the major fiber/carpet/chemical companies spend considerable effort in looking into the feasibility of using shredded carpet waste for soil reinforcement in road construction.

Nature provides ample examples demonstrating the benefits of using fibers in soils, such as slope stabilization with plant roots in soils, and animal habitats from soil reinforced with sticks and fibers. It is also a practice dating back to ancient times when straws were added to clay for building construction. Significant research has been conducted since 1960s on soil reinforcement with natural and man-made fibers. It has been widely reported that the properties (especially the shear strength) of soil can be enhanced by fiber reinforcement, resulting in a more stable soil structure with high load-bearing capacities. Fibers specifically engineered for soil reinforcement are available now (e.g., FibergridsÆ by Synthetic Industries) and have been successfully used in many construction projects in the U.S.

Currently, Georgia Department of Transportation and Georgia Tech along with industry partners and state/local government agencies are conducting a joint research program on Utilization of Carpet Waste for Soil Reinforcement in Road Construction. It aims at improving the durability and performance of road; at decreasing the cost for road construction as less soil and chemical stabilizers are needed; and at reducing the environmental impact due to road construction as less land is needed. The novel approach, if proven feasible, could have significant impact on the textile solid waste disposal problem, as it could lead to the use of billions of pounds of carpet waste per year for better roads at lower cost. The project tasks include fiber processing and characterization, laboratory evaluation of the engineering properties of the fiber/soil systems, field trials with road construction and slope repair, and modeling and optimization.

This talk provides an introduction to fiber reinforcement of soil, an overview of the on-going research project, and a summary of preliminary results.

A NEW APPROACH FOR THE RECYCLING OF PET AND NYLON FIBERS

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The lecture will feature a description of current recycling technologies for PET, nylon 6, and nylon 66 and a new approach for the recycling of these materials involving the use of phase transfer agents.

WEAR AND FATIGUE OF MOORING LINES NYLON VS POLYESTER

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Wear and fatigue in synthetic fiber lines depend on a multitude of mechanisms including: cumulative creep to rupture, hysteretic heating due to cyclic loading of filaments or to relative displacement of structural rope elements, internal wear caused by relative movement between yarns or strands, and external abrasion against deck hardware or rough surfaces. Studies undertaken to evaluate fiber, yarn and rope response to each of these mechanism singly or in combination are found to vary significantly with the condition of test including: cyclic load level (both axial and transverse), cyclic strain level, ambient conditions, i.e., temperature and moisture content (whether dry or wet in fresh water or salt).

Cyclic load limits are shown to depend on wave height, wind velocity, mooring line dimensions and properties. The relative durability of nylon vs polyester lines is considered as they are subjected to tensile cycling under storm conditions. While tensile fatigue as a creep phenomenon is operative over the free length of the mooring line, the more critical location of rope deterioration is at its interactive contact with deck hardware.

An ideal mooring system is one which is composed of two segments. The one between the elements of deck hardware (as cleats and chocks) should possess maximum abrasion resistance and high tensile stiffness. The other segment should possess high tensile compliance so as to minimize the cyclic load levels, induced by waves and wind. A review of yarn/yarn wear tests and rope abrasion tests is provided to form the foundation for such recommendation.

COMPLIANT REINFORCED HOSE AND CABLE DESIGNS FOR OCEANOGRAPHIC APPLICATIONS

Walter Paul

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The paper will summarize recent developments to improve the service life of open ocean surface buoy moorings with electrical conductor linkage to submerged sensors through textile reinforced structures.

Tire cord reinforced stretch hoses are used as interface between a sea state following surface buoy and its suspended tether or mooring. Textile structural mechanics was generated using the rubber hose wall and embedded counterhelical arrangements of nylon tire cords for tension and stretch control, and of embedded Kevlar tire cords layers for fishbite protection. When stretched the hose fluid filled hose responds with axial tension and fill fluid pressure buildup. Agreement between predicted and tested performance is good, the predicted behavior depends highly on helix angle, size, cord/inch and thickness of hose wall. Typical working load elongations are up to 30 percent. The hose is vulcanized with molded in terminations becomes a rugged compliant structure with the

feel of a tire.

Electrical conductors are most vulnerable at a buoy mooring interface due to constant rocking and heave and drop motions of a buoy in waves. A cable was developed where electrical conductors are spiraled around a center braided Vectran strength member and are covered with a heavy neoprene rubber jacket. The cable is then formed into a spiral shape and vulcanized. This coil cord is placed inside the stretch hose and terminated through eye splices at each end. The coil cord allows large length changes of the hose by stretching and contracting its coiled spiral geometry, and even high tension buildup will not stretch the spiralled copper conductors.

Extensive fatigue tests of both hose and coil cord have shown excellent endurance, and no electrical and mechanical failure has yet been experienced in at sea deployments, a true improvement of a notorious failure area in oceanographic moorings.

The paper will discuss the modeling, construction, and testing of this combination of textile composite structural assemblies for service in the tough upper ocean environment.

RECENT DEVELOPMENTS IN ELECTRICALLY CONDUCTIVE FIBERS FROM POLYANILINE AND THEIR BLENDS

Antony P. Chacko and Richard V. Gregory

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Electrically conductive fibers have been prepared by solution spinning of very stable solutions of poly (p-phenylene amine) or leucoemeraldine base. Viscoelastic studies have been carried out to determine the stability of the spin dope and their processability. Influence of processing conditions on the physical and chemical structure of polyaniline and the resultant morphology of wet spun fibers have been investigated. Solution spinning and morphology of electrically conductive fibers from polyurethane/poly (p-phenylene amine) blends will be discussed. Electrical and mechanical properties of these new polyblend fibers will also be presented.

SYNCHROTRON X-RAY STUDIES OF PET FIBERS

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Crystallization behavior of PET fibers during the draw process can be measured by taking advantage of the brilliance of synchrotron x-rays in combination with x-ray area detectors having a high dynamic range, such as an imaging plate. Results of wide angle x-ray diffraction (WAXD) can also be correlated with simultaneous Raman spectroscopic measurements under realistic processing conditions. Recent results obtained at the State University of New York (SUNY) X3A2 beamline will be presented. In addition, the development of an undulator beamline capable of simultaneous small angle x-ray scattering (SAXS) and WAXD measurements of fibers under actual processing conditions at the Advanced Photon Source (APS) near Chicago will be discussed.

DEVELOPMENT OF (HIGH PERFORMANCE) POLYVINYLALCOHOL FIBERS

Quin Zheng and Roger Morgan

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The conditions for gel-spinning and hot drawing of PVA fibers have been investigated and the effects of simultaneous orientation and chemical crosslinking in hot water and other solution environments were studied. Fibers with high tenacities (~30 gpd) were produced but more precise control of spinning conditions will be required to obtain consistent high fiber tenacities. The fiber mechanical energy absorption can be further enhanced by boiling water exposure that causes additional crystallization and, also, disorientation of the fiber amorphous regions that result in a softer but high energy absorbing PVA fiber with 30-60% greater failure strain without any compromise in fiber strength. Such treated fibers have the potential to exhibit superior ballistic resistance and cost advantage relative to other fibers.

MOELCULAR MODELING OF INTERPHASES IN FIBERS

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Recent evidence suggests that interphases (or sometimes referred to as intermediate phases) can be present in large amounts in polymeric fibers.

1. These interphases have been proposed as accounting for the unique mechanical properties of spider silk. 2. Interphases are not true thermodynamic phases but result from the geometric effects in semicrystalline polymers. To understand the properties of the interphases, molecular dynamics and molecular mechanics calculations have been carried out on polypeptide chains constrained between two solid surfaces. The solid surfaces represent polymer crystals and the polypeptide chains are the geometrically constrained interphase. The periodic cells are constructed by a Monte Carlo Rotational Isomeric States approach. The complete compliance matrix can be calculated from small deformations of the periodic cell and other physical measures such as free volume can also be directly

calculated from a number of periodic cells. The calculations have been conducted using the Polymer Modeling software from Biosym/MSI.

HEAT RESISTANT PROPERTIES OF POLY(P-PHENYLENE- 2,6-BENZOBISOXAZOLE) FIBER

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Since the early stages of its development, PBO (Poly-p-phenylenebenzobisoxazole) fiber was known to be a high modulus fiber. However, the strength proved to be almost the same as other super fibers, such as p-Aramid fiber. Toyobo Company and Dow Chemical Company performed joint research in the development of PBO fiber and established the manufacturing technologies for PBO fiber. As a result, the strength of PBO fiber increased to almost double that of p-Aramid. PBO fiber not only has superior mechanical properties which are stronger than carbon fiber, but PBO fiber also has excellent heat and flame resistance. For example, the limiting oxygen index of 68 is the highest among organic fibers. In this study, several heat resistance properties of PBO fiber that was spun by our recent technology will be revealed. High temperature strength, high temperature modulus, strength retention after thermal treatment and other properties will be reported. Although the relative strength of PBO fiber decreased proportionally in temperatures of up to 500C, it still maintained 40% of its strength at 500C. PBO fiber maintained 70% of its modulus at 400C. The strength retention after thermal treatment was shown to be superior to p-Aramid fiber. PBO fiber will offer excellent new product potential in high temperature market.

POLY (TRIMETHYLENE TEREPTHALATE) - A NEW POLYMERIC FIBER ITS CHEMISTRY AND PROPERTIES

Hoe Chuah and Houston Brown

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Poly (trimethylene terphthalate) (PTT) is an aromatic polyester made by the polycondensation of 1,3-propanediol (PDO) and terephthalic acid. Since most polycondensation polymers exhibit "odd-even" effect on their physical properties, the three methylene units in PTT molecule gave some unexpected properties that could not be interpolated from those of PET and PBT. In this paper, we will discuss the synthesis, properties and how they can be used in fiber applications, with emphasis on carpet and textile fibers.

MOLECULAR MODELING OF POLYMER FIBER MECHANICAL PROPERTIES

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The objective of this on-going work is to demonstrate a polymer fiber which exhibits better performance than the ballistic protective fibers now used for body armor. A key facet of the effort was to employ molecular modeling to guide the decisions made regarding the polymer chemical structure before costly synthesis and fiber spinning trials. Although the prediction of mechanical properties of well oriented fibers from the chemical structure is not well developed, we were able to use group additivity methods and regression analysis of known oriented polymers to provide a framework for prediction of fiber properties. Additionally, molecular mechanics and ab-initio methods were explored to determine their usefulness. The properties of interest were tensile strength, modulus, and elongation as indicators of toughness. We found that the group addivity methods when used with a regression analysis of similar known polymers can be an accurate predictor of modulus and tensile strength trends. The talk will cover the methodology and results of the modeling effort for predicting mechanical properties of high performance fibers.

FIBER INITIAL MODULUS AS A FUNCTION OF FIBER LENGTH

N. Pan, H.C. Chen, J. Thompson, M.K.Inglesby, S. Khatua, X.S.Zhang, and S.H.Zeroinian

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The size of a specimen affects its mechanical properties and thus is of theoretical and practical importance for studies of the rupturing process during loading of a fibrous structure. This study investigates the overall effects of fiber length on all three of the most commonly used fiber mechanical properties, namely strength, breaking strain and, initial modulus. Particular emphasis is placed on initial modulus and on the interactions between all three parameters. The influence of strain rate on the size effect is also examined.

Both brittle and ductile fiber types were investigated in this study. It was found that the gauge length at which the fiber was tested affected the fiber strength, breaking strain and, more importantly, initial modulus. It is common knowledge that a fiber becomes stronger as its length is reduced, but less commonly known that it becomes more extensible. However, contrary to the widely accepted assumption that fiber becomes stronger as its

length is reduced, but less commonly known that it becomes more extensible. However, contrary to the widely accepted assumption that fiber initial modulus is independent of its length, the results of this study have shown that the fiber initial modulus decreases as fiber length is reduced. In other words, a fiber of shorter length will become stronger, more extensible but less stiff in extension. This conclusion is found valid regardless of the strain rate.

The implication of this size effect on fiber initial modulus is profound. First, it can hence be deduced that the increases in both strength and breaking strain of a fiber with progressively shorter gauge length are the accumulated results of every tiny segment of the whole fiber. Furthermore, the reason that the modulus of the fiber decreases is due to the fact that fiber length influence changes the strength and breaking strain of a fiber by different amounts. The significance of our finding is that the models predicting the fibrous systems behavior based on the chain of sub-bundle theory all assume that the modulus of the fiber is independent of fiber length. This assumption is now shown to be incorrect.

Several experimental techniques have been employed to validate our findings as follows. An image analysis method has been used to measure the real fiber deformation, and another was used to check the possible machine lag effect. Tests at a wide span of fiber length have been performed. All the results support our conclusions.

SINGLE FIBER ACOUSTIC EMISSION AND TENSILE PROPERTIES FROM COTTON BUNDLE FRACTURE TESTS

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and Clarence D. Rogers

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We have developed an instrument to detect and analyze the acoustic emission generated during tensile fracture of each of the single fibers in a beard containing 100-150 fibers. The acoustic pulse height and width are recorded coincident with the tensile breaking load and breaking elongation. Ten different varieties of cotton fibers were tested on the instrument and on standard HVI equipment. A non-linear relationship was found between the acoustic pulse height and breaking load, as well as between the acoustic pulse energy density and the work of rupture of the fibers. The acoustic pulse energy density is a new datum unrelated to HVI data, and hence it can be used as an additional parameter for classification of cotton fibers.

FROM BEVERAGE BOTTLES TO FORTREL ECOSPUN - TECHNOLOGICAL CONSIDERATION

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PET post consumer containers are the most recycled plastics packages in the world. In the United States PET is being recycled from deposit programs as well as curbside collection schemes. In 1995, 32% of all PET post consumer packages were recycled in the United States.

PET has been recycled into industrial and home fashions end product since the late 1970's. Beginning in 1993, recycled PET soda bottles have been used to make polyester fiber for fashionable polyester apparel. This paper will discuss PET recycling beginning from its source as a post consumer container through to the manufacture of PET fiber. The fashion uses of PET post consumer material will also be addressed in this paper.

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