Scientific Study of Flock Materials and the Flocking Process

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ABSTRACT

Flocking involves the application of fine particles to adhesive coated surfaces. The majority of flocking is done using finely cut natural or synthetic fibers. The focal points of this investigation are modeling of flock fiber motion in an electric field, objective characterization of flock fibers and flocked surfaces, and modeling of fluid transport through flocked surfaces and assemblies. Thus far, laboratory-scale flocking equipment has been acquired and is in the process of being operationally evaluated. Flock test equipment: Conductivity Meter, Flock Motion Tester, Flock Display Unit, High Tension Meter, Siftability Tester, and an Abrasion Tester have been acquired and rendered operational. Studies employing this test equipment have been outlined. Application of flock materials technology to the study of specialty filtration processes is being planned for Year 2 of the project.

OBJECTIVES

1. Develop a fundamental understanding of flock motion in electrostatic, gravitational and pneumatic force field as it exists during the flocking process.
2. Establish an understanding of textile based flock materials and processes from the standpoint of test procedures as they pertain to materials processing properties such as electrical conductivity, and fiber motion.
3. Develop a fundamental understanding of some of the functional properties of flocked surfaces such as durability, coloration and color measurement.
4. Understand fundamentals of controlling fluid transport phenomena through specifically designed flocked surfaces and assemblies.

INTRODUCTION

Flocking is the application of fine particles to adhesive coated surfaces. The majority of flocking done uses finely cut natural or synthetic fibers. A flocked finish imparts a decorative and / or functional characteristic to a surface; decorative and visual appeal, friction modification, thermal insulation and stability, transitionless power transmission, liquid retention or dispersal, buffing and polishing, surface cushioning and component protection.

The variety of materials that are applied to numerous surfaces through different flocking methods create a wide range of end products. Flock fibers are usually applied to adhesive coated

surfaces mechanically, electrostatically, or by a combination of both techniques. Mechanical flocking can be further divided into airblown and beater-bar methods. Electrostatic flocking sometimes incorporates a pneumatic assisted process to propel fibers toward a surface in an airstream. The flocking process is used on items ranging from retail consumer goods to products for high-technology and military applications

Even though flocking technology has existed for a long time, there lacks a fundamental understanding of the material, process, and application issues relevant to the field. The U. S. flocking industry is far behind the European Union (EU) countries in their scientific and technical understanding of the flocking process. It is important that the U. S. flocking industries understand more fully this existing technology and expands upon it in areas more specific to U. S. flocking industry needs. This project will create a scientific basis for this expanding, high added value textile area. These and related industries stand to benefit from this project.

TECHNICAL APPROACH

These specific points will be the overall focus of this research:

1. Describe the behavior of short fibers in an electric field.
2. Delineate of the fiber materials' properties that are important to carrying out an efficient and effective flocking process.
3. Study the rheological, wetting dynamics and adhesion aspects of short fibrous particles impacting an uncured adhesive coating.
4. Study the flocked materials and process parameters that lead to the creation of functionally durable flocked products.
5. Probe coloration and color measurement and matching of flock materials and flocked surfaces.
6. Describe and model fluid transport phenomenon in flocked surfaces and assemblies.

ACCOMPLISHMENTS TO DATE

This project began in May 1997. The following has been completed as of September 1997.

Literature survey was done by searching the CD data base supplied by Textile Technology Digest; two hundred eighty nine (289) flocking related articles and patents were uncovered. Documents from the search have been acquired and are being evaluated. We learned that much of technological flock literature was published in the German and Russian Languages. Only the recent publications are translated into English. We found a few rudimentary analyses on the flocking process, the characterization of products and flock fiber materials. Forty two (42) flocking related patents were listed in our literature survey (from the last 25 years). We are in the process of searching the US Patent on CD database which has been acquired by the University Library. We have found that there is one unique flocking process in which a high potential electric field is not needed to align the flock fibers from dosing device. This process is referred to

as the tribocharging method. It employs friction in imparting a charge onto the flock fibers before their deposition into the adhesive coated substrate. [1]

Two types of flocking machines were purchased: 1) Portable Flocking Unit (Model HEK 100, Maag Flockmaschinen,GMBH) and 2) Electrostatic-Pneumatic Flocking Plant (Model EPF, Maag Flockmaschinen,GMBH). This flock sample preparation equipment has been set up and rendered operational. Several experiments have been conducted to familiarize us with its operation. The hand held flocking unit was used to flock nylon 6/6 fibers on to Polyvinylchloride (PVC) plates. Several commercially available water based flock adhesives were studied. Thus far, an Acrylic polymer / water based emulsion adhesive system (BF Goodrich FL1059B) was found to be most appropriate for our preliminary evaluation of the flocking equipment. This adhesive was also found to be useful for flocking nylon onto nylon surfaces. The fabricated flock samples were examined for flock uniformity and integrity of bonding. These evaluations are continuing.

Various flocking technology test instruments were acquired, set-up and rendered operational. These are: Conductivity Meter (DMB-6F), Flock Motion Tester (SPG 1000), Flock Display Unit (Flock-In-Spect), High Tension Meter (HMG-A), Siftability Tester (RPG 1000), and Abrasion Tester (APG 1000). Fundamental studies on flock motion, fiber conductivity, moisture content of flock materials and electrostatic voltage distribution in the flock spray zone are in progress.

Windows 95 based Color Measurement and Control Software (Pro Palette, Macbeth) has been purchased. This one has different algorithms for color matching. The software will be installed and database will be set up. To establish the database, substrate, dye classes and concentration have been selected. The calibration dyeing will be done in spring 1998. Color matching and objective measurement of flock materials and flocked surface coloration are yet to be developed.

WHERE DO WE GO FROM HERE?

The application of flock technology to the study of specialty filtration processes will be the focus of the project in Year 2. Currently, we plan to conduct preliminary studies on delineation of parameters controlling transport of fluids through flocked surfaces and their assemblies. This is the only remaining objective to be completed for Year 1 of the project. This will ultimately lead to determining the uniquely designed surface geometry and surface activity requirements for sorption and filtration applications of flocked systems.

Additionally, in Year 2 and beyond, we will carry out the following fundamental studies to:

1. describe the behavior of short (dielectric) fibers in an electric field.
2. Delineate the fiber materials' properties that are important to carrying out an efficient and effective flocking process.
3. study the rheological, wetting dynamics and adhesion aspects of short fibrous particles impacting an uncured adhesive coating.
4. study the flocked materials and process parameters that lead to the creation of functionally durable flocked products.
5. probe coloration and color measurement and matching of flock materials and flocked surfaces.

INDUSTRY OUTREACH

UMD's Textile Sciences Department and American Flock Association sponsored a technical seminar, " Fundamentals of Flocking", August 6-8, 1997. During the seminar, over fifty (50) participants from the US flocking industry toured our Flock Technology Research Lab. The new flock processing and testing equipment acquired through the NTC funding was exhibited.

IMPACT ON TEXTILE EDUCATION

Studies employing the acquired test equipment have been outlined for several UMD undergraduate textile chemistry students. Application of flock technology to the study of specialty filtration processes is now being planned as a graduate student research project. Research on color measurement and matching of flocked surfaces is now under consideration as a second graduate student thesis topic.

REFERENCES

1. US Patent: 5,618,588, Apr. 8, 1997 , Inventor: Kjell Alm, Assignee: Sealflock Aktiebolag.