RESEARCHER'S TOOLBOX

Useful Microwave Technology

In a few short years, the handy microwave oven has become very ubiquitous *(ubiquitous: adj, seeming to be present everywhere)*. In view of its speed, economy, efficiency and convenience, it is not too surprising that this tool has made its way out the kitchen into a wide variety of other applications.

The adaptation of microwave technology to applications within the textile and nonwovens industries has been somewhat slow and still rather limited. Through the efforts of several groups, however, this situation is changing, and the microwave system is finding its way into numerous uses in the production plant and also in the laboratory.

The first commercial use of microwave heating for a textile drying unit operation was probably the application to drying rayon filament yarn bobbins. In this application, the wet, freshly spun and washed filament bobbin was placed on a conveyor that slowly passed through a zone of microwave radiation. Each individual bobbin was rotated on its axis as it slowly traversed its path through the drying zone. Bobbins of dry filament were removed from the unit.

The first use of a microwave system in the laboratory was undoubtedly the drying of small textile fabric samples as a part of the determination of moisture content. For this application, the speed and convenience were unparalleled by other methods. However, this method and other similar trial efforts highlighted a major problem with the microwave systems available — uniformity of the treatment. In the kitchen microwave oven, the target is often on a turntable to provide multiple passes in front of the source to hopefully even out randomly occurring hotspots. Unless the treatment is done uniformly, hotspots can develop, resulting in over-heating in some areas and under-heating in others.

To correct this problem, recent work has focused on the use of "waveguides" to serpentine the microwave energy back and forth across whatever material is being treated. With proper design of the waveguides and supporting equipment, a specific environment for the particular wavelengths can be created to provide a controlled distribution of the microwave energy, making it possible to achieve uniform exposure to any material moved though a channel or space. In some designs, the waveguide itself acts as the treatment space and the positioning (top, bottom, middle) of the material as it travels through the space can provide additional control over the energy picked up by the material.

With this improved uniformity in distribution, some amazing results can be achieved. Two different fabrics can be passed through a carefully designed channel or oven plenum, the one fabric entering wet and the other being dry. On emerging, both of the fabrics are at an equal level of dryness, with no overheating of the dry fabric. This is the type of result that technologists have hoped for from microwave technology, and now it appears to be available.

One company that has been a leader in this work is Industrial Microwave Systems (IMS) of Morrisville, NC (IMS, 3000 Perimeter Park Drive, Morrisville, NC; 919-462-9200; www.industrialmicrowave.com). Their patented design concept is called the "Planar Drying System" and it uses microwave energy focused at specific angles to achieve various treatment possibilities. Some of their applications have involved treating tubular knits, sheets of individual yarns in yarn sizing applications, and others. In a system designed for terry towel drying, faster production speeds were possible with the uniform treatment. An additional benefit in this case was that the fabric had good softness, even though a chemical fabric softener was not employed.

This method has also ben applied to the drying of carpet tile. In this application, uniform drying can be achieved without damaging the backing or substrates, and there was no heat degradation of the carpet material. Significantly, substantially increased drying speeds can also be achieved. Installations have been made up to 30-feet wide and material can be treated in a thickness up to two inches.

This company has recently become involved in several nonwoven applications, one of which has been assisted by a grant from the federal Department of Energy, which is interested in the energy saving possibilities with this type of system. This has involved direct drying, drying of printed webs and coated webs, as well as treatment and drying of composite and laminated structures.

The system has also been applied to thermosol dyeing; in this case the excellent uniformity has virtually eliminated the usual liquor migration in the treated fabric, resulting in more uniform dye distribution. With a suitable design, microwave drying in a dye beck or jet dyeing unit can be achieved with a temperature variation within the fabric rope of only 0.1^{0}C.

The beauty of the microwave system is the fact that the energy absorption can be controlled to a rather fine degree. The oscillating microwave energy is not absorbed to any degree by nonpolar materials. This includes most polymeric materials and most fibers of interest to the textile and nonwoven industries. The polar water molecules held within a nonpolar matrix do absorb the energy very efficiently, as they attempt to oscillate in a synchronous manner to the microwave oscillations. Because of the velocity of the oscillations, the water molecules become heated, putting them in an ideal condition to be evaporated from the substrate.

As soon as the substrate has lost its water content, no further absorption of the microwave energy occurs, and so the substrate does not heat up, but can actually begin to cool. As a consequence, the energy absorption can be very specific to water if the proper system is employed.

Other molecules in addition to water will absorb microwave radiation, so applications beyond drying are also possible. Metals absorb energy from a microwave source. This feature results in some limitations, but also in some unique applications. For example, fine metal powder can be suspended in an inactive medium, which is printed onto a substrate. Only the printed pattern is heated as the substrate traverses a treating system. Many other variations have been conceived for exploitation of the system.

Numerous laboratory uses for microwave treatment are evolving and finding utility in a variety of applications. These will be discussed further in a subsequent issue of the *International Nonwovens Journal*.

Nonwoven Processing Equipment at Texas Tech

A frequently encountered problem in nonwoven development work: A good concept needs further work and some pilot trials, but the necessary equipment is not available!

One of the most effective solutions to this dilemma is to seek the necessary equipment elsewhere and to make arrangements to use the equipment on a temporary basis. In these circumstances, the facilities at various universities is often the answer. Such facilities can generally be leased or otherwise be made available on a fee basis. This can frequently be accomplished, with the added bonus that skilled operating personnel can also be obtained. When the right location is identified, this can be an elegant solution to the problem.

A few years ago, INDA organized a

PORTABLE SPECTROSCOPY OFFERS A SOLUTION TO AN AGE-OLD RESEARCH PROBLEM

Every now and then laboratory scientists are given a problem where they wished they could take their laboratory into the plant, the customer's operation, or some other remote location to study a particular situation. The scientist has often been convinced that if only they could get the infrared unit or some other equipment into a particular location, the answer could be easily obtained.

A sizeable step forward in making that wish come true is the advent and advances associated with portable spectroscopy units. Feature articles in this Department in previous issues of the *International Nonwovens Journal* have dwelt with the advances being made in equipment to assist in identifying plastic materials slated for recycling efforts. Now, further powerful equipment and capabilities have advanced beyond, with the development of portable spectrometers with broad capabilities and even portable FTIR equipment.

The Tristan line of spectroments typifies some of these advances. This particular product line is the development of an alliance of three German companies that brought their specific talents together to develop this sophisticated system. The company m-u-t GmbH brings their engineering and development experience on R&D operations to the alliance. Photon Technology International Inc (PTI) has broad experience in spectroscopy, as does PhotoMed GmbH, with special skills in applications.

Together, the group has developed the portable and versatile Tristan unit, which can measure absorption, reflection, transmission and fluorescence by measuring the wavelengths and intensities of light emission. It can rapidly and simultaneously detect the entire spectral output of light from ultraviolet to the near infrared, along with an extended-red sensitive version. The unit includes the light sources, probes, sample handling accessories, optics system, computer for control and recording of spectra. Developed applications include analysis of ingredients and raw materials, textile color control, identification of plastics, glass and other recyclates. A power source allows eight hours of remote operation. (Photon Technology International, 1009 Lenox Drive, Suite 104, Lawrenceville, NJ 08648; 609-896-0310; Fax: 609-896-0365; www.tristan-home.com)

Portable FTIR technology has been used for a wide variety of analyses, including organic chemicals, inorganic materials, clays, soils, paints and other coating materials, petrochemicals, petroleum products, adhesives, plastics and others. An interesting application that has quite fully exploited the potential of this portable equipment is in connection with the examination of paintings, sculpture and other art objects.

In this case, the on-site capabilities, as well as the non-destructive character and the adaptability to extremely small sample size have been significant advantages. This has allowed art conservators and experts to authenticate art objects and also to eliminate fraud and counterfeit items. Further, this technique has been very useful in examining deterioration and guiding restoration efforts. One additional interesting use for portable FTIR has been in examining petroglyphs on stone walls and in caves at some remote archeological sites.

Maybe that difficult problem out in the plant can be studied and solved with FTIR analysis after all.

INTC 2001: A GREAT TOOL FOR BOTH THE INDA AND TAPPI TECHNICAL COMMUNITY

The 2nd Annual International Nonwovens Technical Conference (INTC) 2001, co-sponsored by TAPPI & INDA, will be held September 5-7, 2001 at the Renaissance Harborplace Hotel in Baltimore, Maryland. Over 80 technical papers will be presented in 14 sessions, making INTC 2001 one of the largest technical conferences ever in the nonwovens industry.

Combining the TAPPI Nonwovens and INDA technical conferences has worked out for the better of the technical nonwovens community. One example is found in the Properties and Performance session. Norm Lifshutz will present results on the development of a fiber length test method conducted in a TAPPI Fiber Length task force, while Mike Thomason will present INDA test methods on behalf of the INDA Test Methods Committee.

Other sessions of focus are: Absorbents, Barrier, Binders & Additives, Filtration, Finishes & Surfaces, Mats & Insulation, On-Line Measurements, Polymers & Fibers, Properties & Performances, Sustainability, and four sessions have been devoted to new process technologies.

INTC 2001 will once again offer attendees the nonwoven tutorial taught by industry veterans, Roy Broughton, of Auburn University, Terry Young, Procter & Gamble, and Alan Meierhoefer, Ahlstrom Fibers. Other returning favorites include the Student Paper session, the New Technologies Showcase and the evening tabletop event and reception.

The six technical committees of the TAPPI Nonwovens Division — Properties and Performance, Process Technology, Building and Industrial Mat, Binders and Additives, Polymers and Fibers, and Filtration — will meet during the lunch sessions on September 5th and 6th.

Written papers are due to INDA by June 26 and presentations in electronic form are due to TAPPI by August 1.

For conference or registration information regarding INTC 2001, visit INDA's website at www.inda.org or call 919-233-1210.

survey of the nonwoven process and testing equipment available at the major universities in the US; a report of the facilities available at that time was prepared. Material from this report is currently available at www.inda.org.

With an announcement coming out of Texas Tech, a new location and their new process equipment now needs to be added to this roster. Texas Tech University in Lubbock, TX has recently added some advanced needling equipment, which puts them in a potent position to become deeply involved in nonwoven technology. This equipment is being added to the International Textile Center at Texas Tech, under the direction of Dr. Seshadri Ramkumar, Adjunct Professor at Texas Tech.

The Nonwoven Laboratory at the International Textile Center will be the first facility in the U.S. to have this needling capability. It is based on the state-of-the-art Fehrer H1 Technology needlepunch loom. The principle of the H1 Technology and of this equipment is the special properties that can be obtained by oblique angled needle penetration. This unique capability is achieved by means of an asymmetrically curved needling zone, accompanied by a straight needle movement. Because of this design, some fibers are punched or inserted at an angle rather than in a vertical direction. According to the design developer, the advantages of this new technology include the following:

1. The longer needle path results in better fiber orientation and fiber entanglement than the conventional needle machine.
2. Superior web properties can be obtained with fewer needle penetrations.
3. It greatly enhances the construction of composite and hybrid products.
4. It delivers increased productivity versus conventional needlepunch looms.

The processing line includes units for complete processing, from bale to finished fabric. A Tatham Card fitted with a three-roller/seven-roller design is fed by a Tatham Single Automatic Feeder, Model 503; this latter unit is equipped with a volumetric delivery system. A Microfeed 2000 unit is included in the line to monitor the fiber delivery from the chute section of the volumetric hopper and to speed of the card feed rollers; this compensates for any discrepancy between the pre-programmed "target" weight and the continuously monitored "actual" weight. Thus, the Microfeed unit ensures extremely accurate fiber delivery into the card unit. The web from the card is delivered from the single doffer section of the card to a Tatham conventional design crosslapper. The line is equipped with an AC Inverter-controlled drive system.

A research program focusing on this new line has been supported by a research contract from the Soldier and Biological Chemical Command of the U.S. Department of Defense. The major objective of this research program is to develop special protective fabrics that can be used by the Command to provide advanced textile materials to all branches of the military.

Additional information can be obtained from Dr. Seshadri S. Ramkumar, Texas Tech University, International Textile Center, Box 45019, Lubbock, TX 79409; 806-747-3790, ext. 518; Fax: 806-747-3796; s.ramkumar@ttu.edu; www.itc.ttu.edu/ram.htm.

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