Using the Thermo Scientific DCA RADIAN to develop new products to save the environment

Thermo Fisher Scientific, Process Instruments, Newington, USA

Environmental issues are clearly gaining impetus in the 1990's as governments around the world continue to push for stricter regulations and "greener" products that will reduce waste and control pollution of all kinds. Surface chemistry has played a major role in this quest for a cleaner planet, and the Thermo Scientific DCA RADIAN has helped scientists and engineers to create a number of new products that have made a significant contribution to this cause.

New printing inks

Traditional solvent-based ink formulations are rapidly being replaced by less-toxic and more environmentally-safe water-based inks. The advantages of a water-based ink are obvious when one considers the additional costs and damage to the environment that is associated with the disposal of hazardous wastes, and the health risks associated with workplace exposure to solvent fumes. Switching over to a water-based ink formulation, however, does not come without an investment at the R&D level.

To be a successful formulation for a given application, the adhesion between the ink and the substrate must be recharacterized and optimized to match the characteristics of the new ink/substrate system. This matching of ink to substrate can be approached from two sides. On one hand, the surface tension and polar character of the ink formulation can be modified with the addition of surfactants and other surface active compounds.

The substrate itself can also be modified by utilizing a number of chemical and electronic surface treatment procedures such as chemical etching and exposure to a gas plasma or corona discharge source.

These procedures to change the surface work by modifying the surface energy of the solid with a combination of both mechanical roughening and chemical reactions that alter the surface without affecting the bulk properties of the substrate.

Characterizing the effectiveness of these surface modification procedures in altering the surface energy of a film or paper surface is easily done with the aid of a dynamic contact angle (DCA) experiment. By using a series of pure liquids of varying surface tension and polarity, the surface energy of most any substrate surface can be easily measured with the DCA. In addition, the polar character of an ink formulation can also be determined with the aid of the DCA's tensiometric capabilities.

New pesticide products

To improve the safety and effectiveness of a pesticide formulation, scientists at the USDA and industry research labs around the world are discovering new ways, for example, to improve the adhesion and thus increase coverage of a pesticide to plant material. By learning to distinguish the surface characteristics of one species of plant from another, the adhesion of a pesticide formulation can be optimized for a particular type or species of plant material. The net result is a decrease in the quantity of pesticide required to protect the plant, and thus a decrease in the concentration of pesticide transferred to the environment thru runoff into the soil and groundwater.

Another issue of environmental relevance that relates to pesticides involves the disposal of containers used to package the pesticide formulations. Environmental protection agencies are concerned that once the containers are disposed into a landfill, the residual pesticide solutions that remain on the inside walls of the package will be transferred into the soil and the vapors transmitted thru the air. Efforts are underway now to modify the packaging materials such that the inside walls will contain the pesticide without leaving a residue behind. By modifying the surface energy of the inside walls of a plastic container or applying a non-stick coating on the inside walls of a glass or metal container, the residue remaining in the container can be minimized.

The DCA has been effectively used to address both of the above - mentioned pesticide applications. The contact angle of a blade of grass or a leaf surface has been used, for example, as a sample with the DCA to distinguish between uncoated and coated surfaces of various plant material species and in accessing the adhesion of various pesticide formulations.

Biodegradable and recycled paper products

With the growing shortage of landfill sites, recycling and biodegradable products have grown in popularity as an effective means of reducing the volume of material being disposed into the environment. New paper products, for example, are being developed that are formulated with photosensitive coatings and additives that make the products more biodegradable.

In addition to making paper products more biodegradable, scientists are also exploring new ways to improve the recycleability of everything from newspapers to paper wrappers to milk cartons. By creating new chemicals that effectively remove the ink from the surface of the paper, the recycling process is greatly improved. This application is unique in that it

involves a dewetting or removal of a material (ink in this case) from a surface. In any case, dynamic contact angle analysis has been applied to characterize these new formulations and to improve the efficiency of the recycling process.

Conservation of historical materials

The harmful effects of acid rain and air pollution in the environment has taken its toll on historic landmarks such as marble statues, paper documents, and film records. To combat these effects, researchers in conservation societies and chemical companies are scrambling to develop protective coatings that can be applied to these surfaces to offer protection from the elements. In European countries such as Italy, for example, the number of historically significant and obviously irreplaceable marble statues dating back many centuries is enormous. By applying a coating that will adhere to the marble and thus form a protective coating the structure will be able to withstand many more years of harmful exposure.

The DCA has been applied to develop protective coatings that adhere to the surface of the marble while presenting a hydrophobic surface to the environment that will resist attack.

These are just a few examples of environmentally-related applications in which the DCA has been applied. As time goes on there will no doubt be many more.

Thermo Fisher Scientific
Process Instruments

International/Germany
Dieselstr. 4,
76227 Karlsruhe
Tel. +49(0)721 40 94-444
info.mc.de@thermofisher.com

Benelux
Tel. +31 (0) 76 5 87 98 88
info.mc.nl@thermofisher.com

China
Tel. +86 (21) 68 65 45 88
info.mc.china@thermofisher.com

France
Tel. +33 (0) 1 60 92 48 00
info.mc.fr@thermofisher.com

India
Tel. +91 (22) 27 78 11 06
info.mc.in@thermofisher.com

United Kingdom
Tel. +44 (0) 1785 81 36 48
info.mc.uk@thermofisher.com

USA
Tel. 603 436 9444
info.mc.us@thermofisher.com

www.thermo.com/mc

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