Coating lets ink-jet prints dry quickly

Digital cameras, computers, and ink-jet printers can turn home offices into color photo labs. To make high-quality images that dry almost instantly and don't smear, ink-jet printers need specially coated photographic paper and transparency sheets. A new report describes a coating that enables the newest papers to give sharp, bright images.

Bulent E. Yoldas, formerly of Carnegie Mellon University in Pittsburgh, developed a coating by combining an inorganic compound, a polymer, and an organic binder. Placed on paper or plastic, this thin film, less than 20 micrometers thick, immobilizes water-based ink droplets in about 30 seconds. "By the time it comes out of the printer, the print is dry," Yoldas says.

Ink-jet printers shoot tiny, closely spaced ink droplets onto a surface (SN: 4/10/99, p. 232). Color printers generate a spectrum of hues by combining cyan, magenta, yellow, and black. Since the printer deposits as many as 600 dots per inch of watery ink, prints on most surfaces take from 3 to 5 minutes to dry—plenty of time to get smudged by a stray thumb or the next page to print.

The earliest photo papers developed for ink-jet printing used a gelatin coating much like the ones on traditional photo paper, says Mike Sproviero, manager of research and development at Hewlett-Packard's ink-jet division in San Diego. "These work pretty well but tend not to have a good drying time," he says.

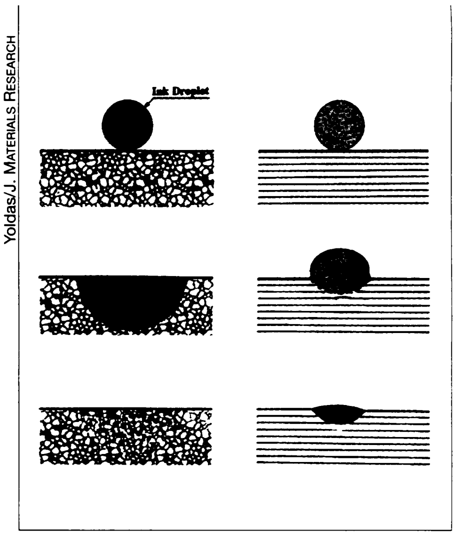
Newer, porous coatings made of inorganic materials dry immediately, quickly soaking up the ink like a sponge, but they have other drawbacks. The ink diffuses into the film, so the dots don't have sharp edges. Also, "there's a finite amount of ink [the film] can absorb," says Sproviero. "If you put too much ink down, it will flood. The colors will bleed together and look horrible."

The films developed by Yoldas and those now used by Hewlett-Packard work in a different way. The polymer molecules absorb the water in the ink, causing the film to swell like a balloon. The film can expand to seven times its original thickness. Since the water is securely bound to the polymer, the ink is effectively dry.

Eventually, the water evaporates, leaving the colored dyes on the film's surface. "The brilliance of the color stands out," says Yoldas. In contrast, colors in the porous coatings lose their intensity because most of the dyes rest beneath the surface. He describes the mechanism underlying the newest films in the June JOURNAL OF MATERIALS RESEARCH.

Although Yoldas' films give sharp, glossy prints, the images fade within days when exposed to ultraviolet light.

Yoldas/J. Materials Research



When an ink droplet soaks into a porous film (left), much of the dye is pulled below the surface, decreasing the intensity of the color. Another type of film (right) swells when it absorbs an ink droplet. When the water later evaporates, the color stays near the surface.

The images printed on Hewlett-Packard's quick-drying photo paper last only 2 years—several years less than they persist on gelatin-coated paper, says Sproviero.

Fast fading may be acceptable for temporary overhead transparencies but not for photos, Yoldas says. Changing the chemistry of the ink may make instant-dry images more colorfast. *—C. Wu*

The buzz: Wings flip, air whirls, bugs lift

Insect flight has long puzzled scientists. In conventional wind-tunnel studies, insect wings generate so little upward force, or lift, that researchers have wondered how most bugs stay aloft. Now, a novel study of the forces on robotic wings may give the first complete picture of insect wing action—albeit a broad-brush portrait—the experimenters say.

As pitchers spin baseballs to make them curve, so flying bugs rotate their wings to gain lift, report Michael H. Dickinson and Sanjay P. Sane of the University of California, Berkeley and Fritz-Olaf Lehmann of the University of Würzburg am Hubland in Germany. Insects also obtain upward boost in each thrust, the study shows, by recapturing energy from the wake of the prior stroke.

Moreover, the new measurements, reported in the June 18 SCIENCE, also confirm 1996 experiments showing that insects acquire lift by tilting their wings sharply into the airflow (SN: 12/21&28/96, p. 390).

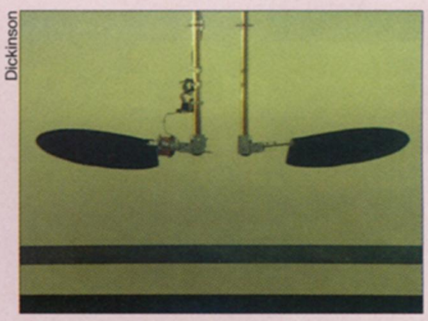
"With these findings, we basically have the palette of mechanisms [for creating lift] that are available" to insects, Dickinson asserts. "It's like a unified theory of insect flight." Nonetheless, because insects exhibit so much variety in their wing-motion patterns, "there is an enormous amount of work remaining to find out how they use these mechanisms," he cautions.

Most insects flap their wings forward and backward, not up and down. The wings move through the air like flattened hands sweeping to and fro. The thumb-side edge would be tilted upward into the oncoming flow, and between strokes, the wings flip, as if the hands were to change from palm down to palm up or vice versa. The insect changes the precise timing of the flips to control flight because those semicircular flips create surges of force on the wings, the new findings indicate.

"This is important stuff," comments Adrian L.R. Thomas of Oxford University in England, a researcher on the 1996 study, which used robotic wings and intact moths. "We suggested [then] that rotational mechanisms were not important," he says. "The whole system is a lot more complicated than we thought."

In general, an airborne object that is turning—be it a ball or a wing —drags a thin layer of air along with its rotation. The speed of the air layer peaks where the rotation adds to the forward motion and dips on the opposing surface, creating a pressure difference and therefore a force. Such forces can make a baseball arc deviously or push a wing up or down, Dickinson says.

Dickinson



Measurements on these 25-centimeter-long Plexiglas wings, slowly flapping in mineral oil, probe equivalent aerodynamics of 1-millimeter-long fruit fly wings, which beat 200 times per second in air.

A decade ago, the Berkeley researcher noticed that fruit flies adjust wing-flip timing relative to overall stroke timing, but he didn't understand why. The new experiments suggest that the timing change alters the force and direction of the push on the wings, giving the animals exquisite maneuverability, he claims.

Besides satisfying scientific curiosity, the new findings should aid efforts to build tiny flying robots for military purposes, scientists say. *—P. Weiss*