INDUSTRY ALLIES

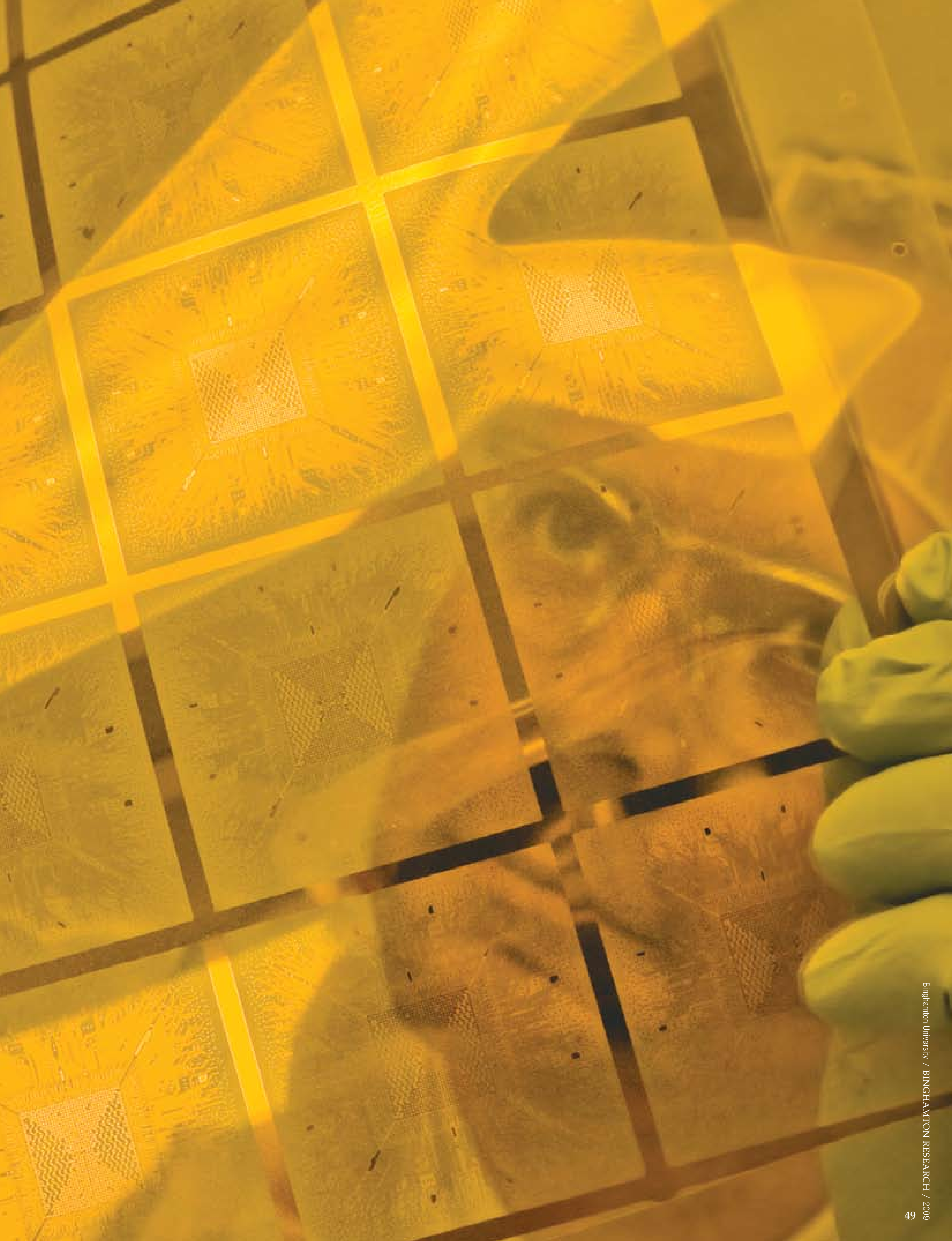
THE CENTER OF EXCELLENCE TURNS CORPORATE PARTNERS INTO CATALYSTS FOR DISCOVERY

Dynamic faculty-industry collaborations fostered by Binghamton University's Center of Excellence result in breakthroughs in disciplines ranging from chemistry and physics to computer science and mechanical engineering.

The projects also help to speed up the process of discovery in new areas, said Bahgat Sammakia, director of the Small Scale Systems Integration and Packaging Center (S^3IP). He noted that flexible electronics — one of the center's core strengths — is such a new field that there aren't many "rules" hindering creativity. "If you don't have too many standards, then you have a lot of freedom," he said. "You can do more research and discover new things."

An unusual model governs the interaction between faculty researchers and companies that are members of S^3IP's Integrated Electronics Engineering Center (IEEC) or Center for Advanced Microelectronics Manufacturing (CAMM).

At the beginning of each year, there's a meeting during which representatives of member companies discuss their research interests. "They give a perspective of short-term, mid-range and long-term issues as well as whether it's a research challenge or a research and development question," Sammakia explained. "These are non-confidential talks, so we post them on the Web and even faculty who did not attend can access them."



Faculty members follow up with questions and develop research proposals. Company engineers evaluate the proposals and help prioritize them for funding and the interests of the center. Sammakia chooses 10 to a dozen projects for funding through the IEEC and a similar number for the CAMM. "Each project has not only funding but also mentors," Sammakia said. "They can work together."

Eric Cotts, professor of physics at Binghamton and co-director of the University's Materials Science and Engineering Program, has researched lead-free solder with support of the IEEC. Strong interactions with people in industry have influenced the focus of his work, he said.

"Corporations tend to distill a problem and have a lot of money focused in particular areas," Cotts said. "It's an engineering approach. They tend to distill a problem down to its basic physics. … It's a good marriage, if you can find a problem where you can work on the basic concepts and use their characterization of the problem. It's fun."

Cotts said he and his colleagues have taken work they've done with industry partners such as IBM, Texas Instruments and Universal Instruments and then developed funding proposals for state and federal sources. "It's important to do basic science just for the sake of science," he said. "And it is good to work with industry. Binghamton is a nascent university. It's a relatively small campus. There are a lot of bright people in industry and it's interesting to talk to them. It's stimulating. It's a great experience for students, too, especially if only 1 in 20 will become a professor."

Faculty members present reports three times during the year. Member companies evaluate the research and offer feedback. This, Sammakia said, is what sets the process apart from other campus-industry projects. The funding model has been around for a while, but it's the feedback mechanism that helps ensure that projects stay on track and that the results will be useful to the sponsors.

Junghyun Cho, associate professor of mechanical engineering at Binghamton, is working on projects related to thin films through both the CAMM and IEEC. The work could lead to flexible solar cell devices and provide materials and processes that will make electronic devices smaller and lighter.

Cho said that in one case the sponsor feedback gave him the confidence to continue with his work, knowing that it did indeed "make sense."

> **“The partner said, ‘This has to be a top priority.’ We upgraded the project. It led to solving some fundamental materials problems.”**
>
> *— Bahgat Sammakia*

CENTER OF EXCELLENCE GOES ‘GREEN’ WITH ENVIRONMENTALLY FRIENDLY PROJECTS

“Green” technologies are central to many initiatives of the Small Scale Systems Integration and Packaging Center (S^3IP), from solar power to lead-free electronics.

- **In 2008, the Center for Autonomous Solar Power (CASP) was established with $4 million in federal funding. CASP will focus on tapping into the sun’s immense supply of renewable energy and make it easily accessible as a flexible, large-area and low-cost power source. The multidisciplinary center, led by Director Seshu Desu, will focus on areas such as solar conversion efficiency, storage capabilities, solar module stability and power system cost reduction. CASP will enable people to use solar power in ways and places they never have before.**
- **Faculty member Howard Wang and his colleagues continue to explore the possibilities of printed electronics, which may reduce the materials wasted and energy used in production. The key there is using an additive process, rather than a traditional subtractive process, which involves heavy-duty chemicals and wastes a tremendous amount of copper.**
- **S^3IP offered two summer programs in 2008, one for science teachers and another for promising students. The Go Green Institute brought together about 50 seventh-graders for an intensive 10-day, hands-on learning experience centered on the theme of a greener living environment.**
- **The center assists with graduate-level classes in electronics packaging and flexible electronics via distance-education technology and often relies on videoconferencing technology rather than having in-person meetings that would require people to travel from around the country.**
- **Ongoing S^3IP projects also include initiatives related to low-power computing, data center thermal management and lead-free electronics.**

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— Mary Beth Curtin

Other projects, he said, just wouldn't have happened without the industry collaborations.

"The partnerships provided motivation for initial work and funding that could support graduate students, data for publication and proof-of-concept experiments that were vital to pursue larger funding from the federal and state governments," he said. "Without this, it could have been much tougher to get into this research area."

Sammakia said the regular research status reports also allow work that turns out to be especially promising to be fast tracked with additional funding and staff. That happened recently with a project focused on process development for packaging. "In the middle of the meeting, the partner turned to me and said, 'This has to be a top priority. We want you to increase the funding for this project and here are some additional questions we want answered.' We upgraded the project, a lot more work was done and, of course, when you do that you get more research and more surprises," Sammakia said. "It led to solving some fundamental materials problems."

Traditionally, sponsoring companies or agencies do not have much contact with researchers for a year at a time. "By that time, if you get misdirected, you may end up not meeting the requirements of your proposal," Sammakia said. "The chances of success are low. You end up doing something interesting and maybe useful but it's not what the sponsor had in mind. We want the work to be not only relevant and important but exactly what the company needs."

Sammakia said the regular industry-faculty meetings have been so successful at the IEEC that they were introduced to the CAMM at its founding several years ago. He anticipates the process working across the Center of Excellence, including in the new Center for Autonomous Solar Power (CASP), which last year was founded with $4 million in federal funding.

With the addition of CASP, the Center of Excellence is building a unique operation with capabilities unmatched by any other facility in the world. The CAMM, which opened its roll-to-roll electronics prototype manufacturing facility in 2008, has tremendous potential in terms of new products as well as economic development, Sammakia said. The first prototype products created at the University's facility at Endicott Interconnect Technologies will be ready this year.

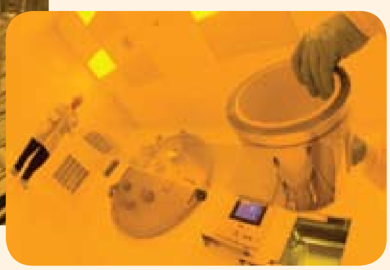
Mary Beth Curtin, associate director of S^3IP, said Endicott Interconnect is already using some of the CAMM's tools to investigate future products and try to commercialize new technologies. She noted that member companies will continue to be an integral part of decisions regarding the CAMM's facilities and its processes.

"The companies are helping us build a technology road map for the CAMM," Curtin said. "As we go forward, they will help us answer questions like: What gaps in tools and infrastructure should we be addressing? How should we be building the center to be of use to our partners? What research questions should we tackle?" ■

— Rachel Coker

Binghamton University's Center for Advanced Microelectronics Manufacturing helps to demonstrate the feasibility of roll-to-roll (R2R) electronics manufacturing with its prototype tools and by establishing processes that produce low-volume test-bed products.

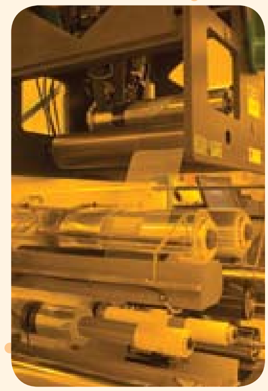
The R2R manufacturing process, one step at a time, as seen at the center:



1 A roll of new material arrives and is inspected for surface particulates, scratches or other imperfections.

2 The material is cleaned.

3 The roll is inspected again to verify the cleaning process.



4 The roll goes to the General Vacuum tool for metallization. The machine precleans (or "wets") the surface just before coating to improve the adhesion of the metal.

5 In the resist-apply phase, a photoresist material is applied with a spray system or through a slot-die wet coating. *(This step is the only one performed off site.)*

6 Now there's an ultraviolet-sensitive roll of material ready to be exposed, much like a roll of film. The material goes through a projection lithography system, which can expose up to 24 linear inches per minute of web.

7 The material goes through a developer and is rinsed and dried.

8 The material is etched, removing the exposed metal that's not needed.

9 A stripping process removes the remaining photoresist material.

10 The metal-patterned roll of material is ready. Possible applications include smart fabrics, sensors and medical devices as well as consumer electronics.