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FAST MOVING FRONTS - 2009

January 2009

PDF

Hiroshi Ito talks with *ScienceWatch.com* and answers a few questions about this month's Fast Moving Front in the field of Materials Science. The author has also sent along images of their work.

Article: Chemical amplification resists for microlithography
Authors: Ito, H
Journal: ADVAN POLYM SCI, 172: 37-245 2005
Addresses: IBM Corp, Almaden Res Ctr, 650 Harry Rd, San Jose, CA 95120 USA.
IBM Corp, Almaden Res Ctr, San Jose, CA 95120 USA.

SW: Why do you think your paper is highly cited?

As the co-inventor of chemical amplification resists, I am considered an expert in this area. All of today's advanced semiconductor devices are manufactured using chemical amplification resists, and my article presents the most comprehensive review to date in this area.

SW: Does it describe a new discovery, methodology, or synthesis of knowledge?

Yes, my article describes a new discovery, development of new resist materials, new lithographic processes, and new methodology, as well as accumulated knowledge in microlithography.

SW: Would you summarize the significance of your paper in layman's terms?

The chemical amplification resists I invented in collaboration with C. Grant Willson and Jean Fréchet have enabled the semiconductor industry make electronics devices smaller, cheaper, and more powerful—keeping pace with Moore's Law, a prediction made in 1965 by Gordon Moore, cofounder of Intel, stating that the number of transistors occupying a square inch of integrated circuit material had doubled each year since the invention of the integrated circuit and that the multiplication of circuitry would continue.

My paper describes the advancement of chemical amplification resists from the time of their inception to worldwide implementation in device manufacture, and the further development to support next-generation lithography (NGL), citing more than 500 references. I believe that my article is now considered to be a textbook of chemical amplification resists.

"Microlithography technology and the semiconductor industry will continue to grow and evolve, and as we continue to innovate, technology will continue to impact our society and the world."

SW: How did you become involved in this research and were any particular problems encountered along the way?

When I joined IBM in 1980, I began working on several projects, one of which aimed at a drastic increase in the resist sensitivity to support deep UV lithography. Use of a photochemical acid generator to induce an acid-catalyzed reaction achieved the goal and also provided a solution to the other two projects. As the three systems were characterized with a gain mechanism, we decided to call these acid-catalyzed resist systems "chemical amplification resists."

View three slides of Hiroshi Ito's work. PDF

The most serious and devastating problem which chemical amplification resists encountered was the formation of a skin or T-shaped profile in developed positive images, due to neutralization of the photochemically generated acid with airborne basic substances absorbed in a top layer of the resist film upon standing, after UV exposure. I was able to solve the problem by reducing the free volume in the resist film through annealing near its glass transition temperature to prevent airborne basic contaminants from diffusing into the film. This resist gained worldwide acceptance, was a workhorse in device manufacture at a 250 nm feature size, and introduced the era of chemical amplification.

SW: Where do you see your research leading in the future?

The chemical amplification resist has enabled the technology industry to keep pace with Moore's Law and benefited the world economy for the last 15 years. In all likelihood, the chemical amplification resist will continue to be employed in subsequent generations of device manufacture down to a 20 nm resolution through innovations in materials and processes and through concerted efforts among diverse disciplines of microlithography.

SW: Do you foresee any social or political implications for your research?

Microlithography technology and the semiconductor industry will continue to grow and evolve, and as we continue to innovate, technology will continue to impact our society and the world. New breakthroughs in chip technology have enabled things we couldn't have even imagined 30 years ago, like handheld devices capable of storing 40 gigabytes or more. And in turn, the breakthroughs we are making today will enable future advances that are still beyond our imagination.

Hiroshi Ito, Ph.D.
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San Jose, CA, USA

Keywords: chemical amplification resists, next-generation lithography, acid-catalyzed resist systems, microlithography technology, semiconductor industry, breakthroughs in chip technology.

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