

Semiconductor Industry Seeks Magic Lantern

Sand, sand everywhere...all potentially high-grade silicon down the road. It is a cool spring night in 2016. A worried process engineer is walking in the desert near the new Silicon Oasis complex. Fab 1, the crown jewel of the complex, is ramping production of 22nm devices. It is not going well. The engineer flips through the micrographs for the thousandth time, shoves his PhotoPod back in his pocket, and kicks the sand in frustration. He yelps as his toe hits something solid, and bends over to yank the rock loose and throw it aside.

Hmm, it is not a rock! It is an old oil lamp, the kind that one typically hears about in mythological tales about genies. He buffs the metal with his sleeve, then jumps backward as a misty column pours out, rising to tower over his head. A deep voice booms, "I am the Genie of the Lamp! What is your command?"

The quick-thinking process engineer is smart enough to know that modest requests are safer than asking for money, women, or endless power. "You wouldn't happen to have a tool for sidewall metrology in dense 22nm half-pitch arrays, would you?"

The column condenses and shrinks, collapsing into an elderly man with a rough beard, thick glasses and a pocket protector. The engineer gapes openmouthed, examining this apparition before him. "Would that be dimensional or compositional metrology?" the Genie drones. "Call me Omar, by the way."

"Ummmm, both, please." The engineer whips out his PhotoPod to show Omar the offending structures, hastily adding, "With high throughput, if it isn't too much trouble..."

Omar looks at the photos, then hands them back. "My fellow genies and I receive many tough requests, from ensuring universal peace to helping the Chicago Cubs win the World Series," he explains. "Yours is especially difficult. You see, those fins are not necessarily vertical. You have to get a probe down inside the features, and sample all the way up. You must use

light or maybe an electrical measurement too, since nothing else will be fast enough or nondestructive enough."

The engineer nods, "I know."

"Unfortunately, the wavelength of light is too long," continues Omar. "You skim right over these features, instead of getting the beam inside. Test structures do not help, either, since what you are measuring depends on the environment around the feature."

The engineer's face falls. He looks really miserable. "I know."

"I am sorry," says Omar. "We have been working on this since 2006, but so far we have not got anything better than TEM or maybe focused ions. Which, I will bet you already know about. Is there something else I can do for you instead? A winning lottery ticket, perhaps?"

"Well, if I don't use a FinFET," insists the engineer. "There's a planar structure I could use instead. No fancy sidewalls, just a stack of thin layers ..."

"Thin, planar films? Piece of cake!" Omar exclaims, rubbing his hands together. "Just thickness and composition?"

"And a small spot size. And..." the engineer hesitates.

"The spot size is tricky, but we can manage it. What else?"

"Well, everything depends on the interfaces. These layers are all interface – they're only a few nanometers thick, and there are about three of them. We need to know how many hafnium-silicon bonds are at the interface, and maybe the interface trap density. Oh yes, and the interface we care about is at the bottom of the stack. Is that okay?"

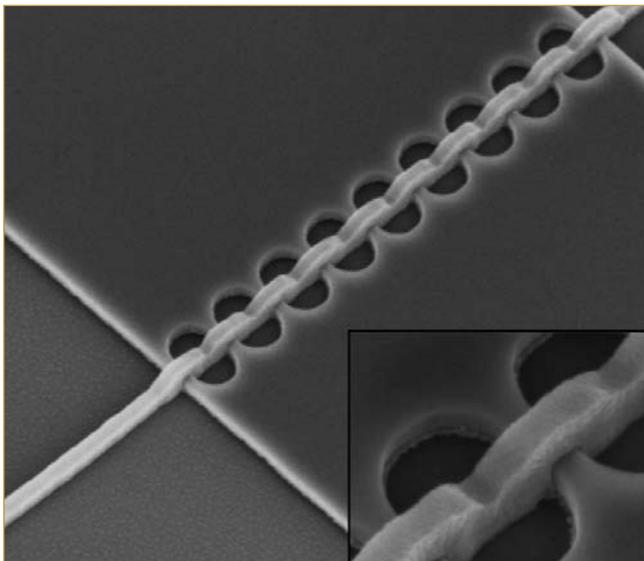
Omar stares at the engineer. Takes his glasses off, wipes his face on his sleeve. Very slowly, he repeats, "You want to count the number of hafnium-silicon bonds. And interface traps. In a 22nm spot. At the bottom of a three-layer stack. To what precision? A few percent?"

"Yes, please," the engineer says eagerly.

Omar stares up into the night sky for a long moment and mutters something under his breath. Finally, he says, "Let us have another look at those photos, okay?"



Katherine Derbyshire
www.thinfilmmfg.com



First 300-mm FinFET lot - IMEC.
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Katherine Derbyshire is writing an introduction to IC manufacturing for non-specialists, tentatively titled *Semiconductor Manufacturing in Nontechnical Language*. She has engineering degrees from the Massachusetts Institute of Technology and the University of California, Santa Barbara. She founded Thin Film Manufacturing, a firm that helps the industry manage the interaction between business forces and technology advances, in 2001. You can reach Katherine at P.O. Box 80229, Stoneham, MA 02180, USA. Tel: +1-781-4389779; E-mail: kderbyshire@thinfilmmfg.com