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"It's too PERFECT to be natural. Things in nature, they have flaws. This diamond is FLAWLESS."

– Jef Van Royen, senior scientist at the Diamond High Council

DAVID CLUGSTON

Yellow diamonds manufactured by Gemesis, the first company to market gem-quality synthetic stones. The largest grow to 3 carats.

A microwave plasma tool at the Naval Research Lab, used to create diamonds for high-temperature semiconductor experiments.

"He said that MY FATHER'S research was

Apollo's Robert Linares, looking through a chemical deposition chamber. His patented method produces flawless crystals of diamond.

a good way to get a BULLET in the head."

– Bryant Linares, president and CEO of Apollo Diamond

photographs by Ian White

"I was in combat in Korea and 'Nam. You better believe I can handle the diamond business," says Gemesis founder Carter Clarke, center. His lieutenants have 27 diamond-making machines up and running – with 250 planned – at this factory outside Sarasota, Florida.

The Diamond Wars Have Begun

Armed with inexpensive, mass-produced gems, two startups are launching an assault on the De Beers cartel. Next up: the computing industry.

by Joshua Davis / photographs by Ian White

Aron Weingarten brings the yellow diamond up to the stainless steel jeweler's loupe he holds against his eye. We are in Antwerp, Belgium, in Weingarten's marbled and gilded living room on the edge of the city's gem district, the center of the diamond universe. Nearly 80 percent of the world's rough and polished diamonds move through the hands of Belgian gem traders like Weingarten, a dealer who wears the thick beard and black suit of the Hasidim.

"This is very rare stone," he says, almost to himself, in thickly accented English. "Yellow diamonds of this color are very hard to find. It is probably worth 10, maybe 15 thousand dollars."

"I have two more exactly like it in my pocket," I tell him.

He puts the diamond down and looks at me seriously for the first time. I place the other two stones on the table. They are all the same color and size. To find three nearly identical yellow diamonds is like flipping a coin 10,000 times and never seeing tails.

"These are cubic zirconium?" Weingarten says without much hope.

"No, they're real," I tell him. "But they were made by a machine in Florida for less than a hundred dollars."

Weingarten shifts uncomfortably in his chair and stares at the glittering gems on his dining room table. "Unless they can be detected," he says, "these stones will bankrupt the industry."

Put pure carbon under enough heat and pressure – say, 2,200 degrees Fahrenheit and 50,000 atmospheres – and it will crystallize into the hardest material known. Those were the conditions that first forged diamonds deep in Earth's mantle 3.3 billion years ago. Replicating that environment in a lab isn't easy, but that hasn't kept dreamers from trying. Since the mid-19th century, dozens of these modern alchemists have been injured in accidents and explosions while attempting to manufacture diamonds.

Recent decades have seen some modest successes. Starting in the 1950s, engineers managed to produce tiny crystals for industrial purposes – to coat saws, drill bits, and grinding wheels. But this summer, the first wave of gem-quality manufactured diamonds began to hit the market. They are grown in a warehouse in Florida by a roomful of Russian-designed machines spitting out 3-carat roughs 24 hours a day, seven days a week. A second company, in Boston, has perfected a completely different process for making near-flawless diamonds and plans to begin marketing them by year's end. This sudden arrival of mass-produced gems threatens to alter the public's perception of diamonds – and to transform the $7 billion industry. More intriguing, it opens the door to the development of diamond-based semiconductors.

Diamond, it turns out, is a geek's best friend. Not only is it the hardest substance known, it also has the highest thermal conductivity – tremendous heat can pass through it without causing damage. Today's speedy microprocessors run hot – at upwards of 200 degrees Fahrenheit. In fact, they can't go much faster without failing. Diamond microchips, on the other hand, could handle much higher temperatures, allowing them to run at speeds that would liquefy ordinary silicon. But manufacturers have been loath even to consider using the precious material, because it has never been possible to produce large diamond wafers affordably. With the arrival of Gemesis, the Florida-based company, and Apollo Diamond, in Boston, that is changing. Both startups plan to use the diamond jewelry business to finance their attempt to reshape the semiconducting world.

But first things first. Before anyone reinvents the chip industry, they'll have to prove they can produce large volumes of cheap diamonds. Beyond Gemesis and Apollo, one company is convinced there's something real here: De Beers Diamond Trading Company. The London-based cartel has monopolized the diamond business for 115 years, forcing out rivals by ruthlessly controlling supply. But the sudden appearance of multicarat, gem-quality synthetics has sent De Beers scrambling. Several years ago, it set up what it calls the Gem Defensive Programme – a none too subtle campaign to warn jewelers and the public about the arrival of manufactured diamonds. At no charge, the company is supplying gem labs with sophisticated machines designed to help distinguish man-made from mined stones.

In its long history, De Beers has survived African insurrection, shrugged off American antitrust litigation, sidestepped criticism that it exploits third world workers, and contended with Australian, Siberian, and Canadian diamond discoveries. The firm has a huge advertising budget and a stranglehold on diamond distribution channels. But there's one thing De Beers doesn't have: retired brigadier general Carter Clarke.

Carter Clarke, 75, has been retired from the Army for nearly 30 years, but he never lost the air of command. When he walks into Gemesis – the company he founded in 1996 to make diamonds – the staff stands at attention to greet him. It just feels like the right thing to do. Particularly since "the General," as he's known, continually salutes them as if they were troops heading into battle. "I was in combat in Korea and 'Nam," he says after greeting me with a salute in the office lobby. "You better believe I can handle the diamond business."

Clarke slaps me hard on the back, and we set off on a tour of his new 30,000-square-foot factory, located in an industrial park outside Sarasota, Florida. The building is slated to house diamond-growing machines, which look like metallic medicine balls on life support. Twenty-seven machines are now up and running. Gemesis expects to add eight more every month, eventually installing 250 in this warehouse.

> A Pentium chip made of diamond could run at speeds that would liquefy silicon.

In other words, the General is preparing a first strike on the diamond business. "Right now, we only threaten the way De Beers wants the consumer to think of a diamond," he says, noting that his current monthly output doesn't even equal that of a small mine. "But imagine what happens when we fill this warehouse and then the one next door," he says with a grin. "Then I'll have myself a proper diamond mine."

Clarke didn't set out to become a gem baron. He stumbled into this during a 1995 trip to Moscow. His company at the time – Security Tag Systems – had pioneered those clunky antitheft devices attached to clothes at retail stores. Following up on a report about a Russian antitheft technology, Clarke came across Yuriy Semenov, who was in charge of the High Tech Bureau, a government initiative to sell Soviet-era military research to Western investors. Semenov had a better idea for the General: "How would you like to grow diamonds?"

A few hours later, Clarke was looking at a blueprint for an 8,000-pound machine that used hydraulics and electricity to focus increasing amounts of pressure and heat on the core of a sphere. The device, he was told, re-created the conditions 100 miles below Earth's surface, where diamonds form. Put a sliver of a diamond in the core, inject

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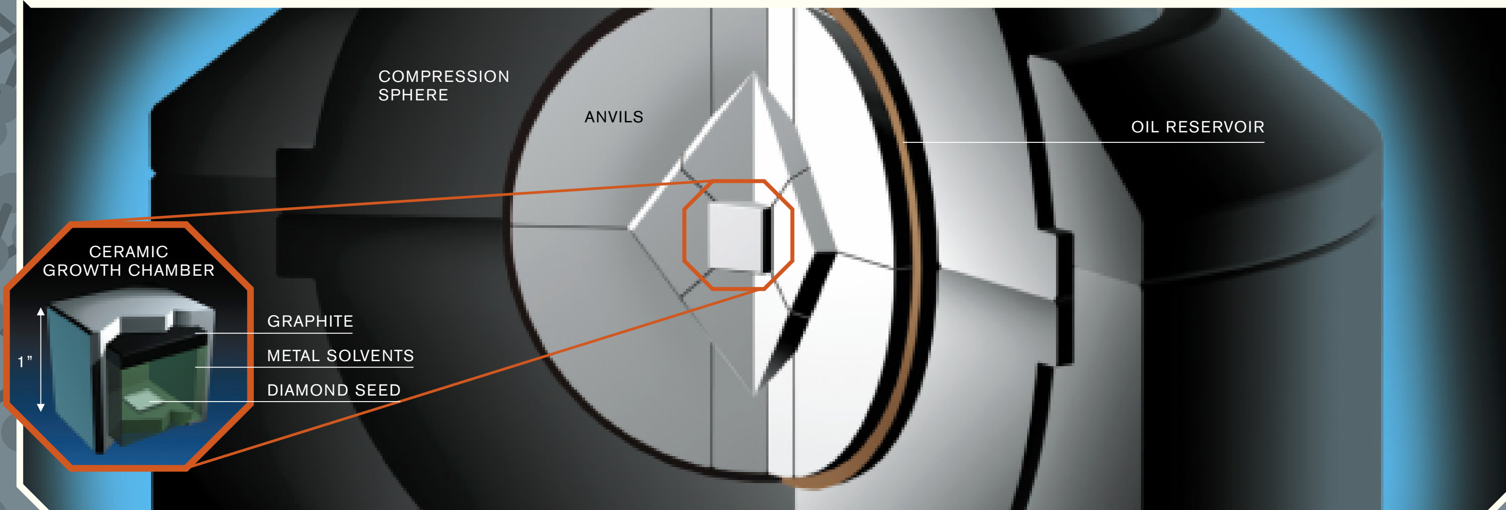
Contributing editor Joshua Davis (jd@joshuadavis.net) *wrote about the Army's tactical Internet brigade in Iraq in* Wired *11.06.*

How to Make a Diamond

THE GEMESIS WAY: High pressure, high temperature. Crystal is created in a chamber that mimics geologic conditions.



1 Place metal solvents and graphite in ceramic growth chamber. Insert diamond seed at bottom of chamber and put chamber in center of compression sphere.

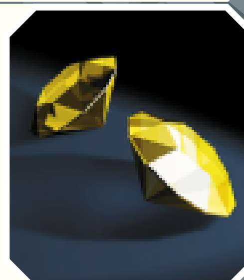
2 Force oil into top layer of sphere, creating pressure against steel anvils. Increasing pressure is transferred through anvils and onto growth chamber. Even with minimal pressure at surface, force at center reaches 58,000 atmospheres.

3 Turn on juice. Current wired to one end of ceramic chamber raises temperature to 2,300 degrees Fahrenheit. Heat and pressure cause graphite – pure carbon – to atomize. Freed carbon drawn to cooler end of chamber bonds to diamond seed, crystallizing layer by layer.

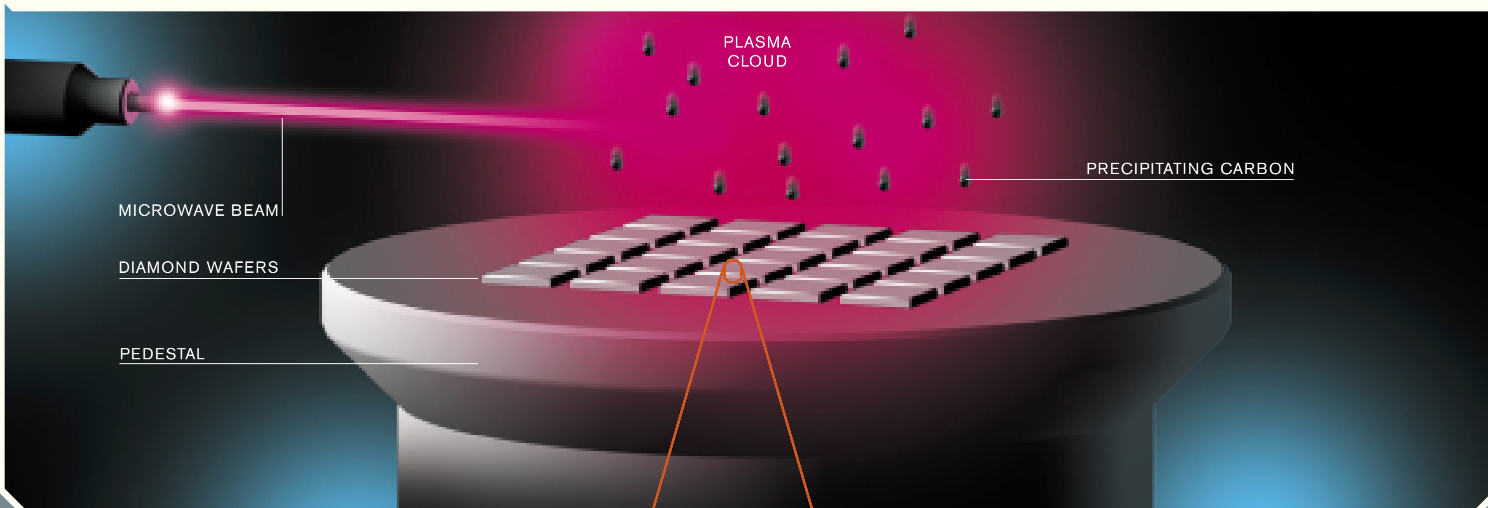
4 

Wait three days.

5 Open machine. Smash growth chamber, pull out stone. Cut and polish to make sparkling diamond gem.



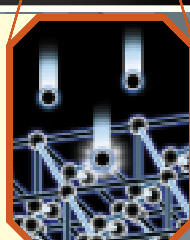
THE APOLLO WAY: Chemical vapor deposition. Crystal is formed when a plasma cloud rains carbon onto diamond wafers.



1 Place diamond wafers on pedestal. Depressurize chamber to one-tenth of an atmosphere.

2 Inject hydrogen, natural gas (CH_4) into chamber. Heat with microwave beam. At 1,800 degrees Fahrenheit, electrons separate from nuclei, forming plasma.

3 Let it rain. Freed carbon precipitates out of plasma cloud and is deposited on wafer seeds.



4 Let it grow. Wafer seeds gradually become diamond mini-bricks, building up at half a millimeter a day.

5 Open chamber and remove diamond brick. Slice into wafers for semiconductors or cut and polish to make gems.

ILLUSTRATIONS BY GIACOMO MARCHESI

some carbon, and voilà, a larger diamond will grow around the sliver.

General Electric managed to do this in 1954 by using a 400-ton press to crush the hell out of carbon. GE's machine economically produced diamond dust for industrial uses, and by the early 1970s the company had even managed to manufacture stones as large as 2 carats. But that effort took so much time and electrical energy, it was more expensive than buying a mined diamond. The Russians claimed their machine was relatively cheap, took no more energy to run than a dozen lightbulbs, and would produce a 3-carat stone in a few days. And the General could have it for just $57,000.

Clarke was skeptical. On the long flight back to the States he tried to forget about the offer and sleep, but the light creeping through his window shade kept him awake. If this thing really could make a diamond, he thought, $57,000 isn't that much money. "Hell," he mused, "what could be more fun than trying to make diamonds?" By the time the plane touched down in New York, he'd decided to give it a shot.

Three months later, Clarke returned to Moscow. Bodyguards met him at the airport and took him to a warehouse outside the capital. In an unheated room in the middle of winter, he watched Nickolai Polushin – one of the original Siberian scientists – lift the top half of the machine's sphere. Polushin pulled out a small ceramic cube, smashed it with a hammer, and handed Clarke a small diamond. Everybody smiled. The General eventually ordered three machines and told Semenov to ship them to Florida.

Abbaschian's efforts had produced some very high-quality stones. So Clarke flew to London to show off a batch to potential investors. Rather than simply present them as a pile of loose diamonds, he went to a jeweler in Hatton Garden, the city's diamond district, and asked if a few of his stones could be set in rings. The jeweler agreed, and Clarke returned to his hotel room at Claridge's. The phone rang. It was De Beers.

According to Clarke, a De Beers executive, James Evans Lombe, was tipped off about the synthetic diamonds within two hours of their arrival at the jeweler's. Lombe asked for a meeting with the General. The De Beers executive drove directly to Claridge's, and the two men sat down in the tearoom to the strains of a piano and violin duet.

De Beers refuses to comment on the meeting – or about anything for this story – but Clarke says he simply placed his diamonds on the table. "When I told him that we planned to set up a factory to mass-produce these, he turned white," the General recalls. "They knew about the technology, but they thought it would stay in Russia and that nobody would get it working right. By the end of the conversation, his hands were shaking."

But De Beers wasn't backing down. Throughout 2000, the cartel accelerated its Gem Defensive Programme, sending out its testing machines – dubbed DiamondSure and DiamondView – to the largest international gem labs. Traditionally, these labs analyzed and certi-

But Does It Pass the Jeweler Test?

We asked three experts if they'd recommend a 1.4-carat yellow Gemesis diamond to their customers.

"It looks nice, but you've got me on the defensive because I have a natural yellow diamond right here that sells for $15,000. There's no way I can recommend their diamond when I've got inventory like that."

Richard Horne
President, Shreve & Co.
San Francisco

"The diamond is jaw-dropping. Nobody's going to know the difference. It's going to allow a whole new class of people to own fancy color diamonds."

David Piccione
Owner, Picciones' Jewelry
Ravenna, Ohio

"I can tell right away these aren't 'real' diamonds! The average person won't be able to, but I can tell just by looking at them. Still, nobody cares how they're created."

Jacob "The Jeweler" Arabo
Owner, Diamond Quasar
New York City

But there were two immediate problems. First, nobody in the US knew how to run them. Clarke solved that by moving a crew of Russians to Florida. ("I felt myself all the time in a sauna," remembers Nickolay Patrin, who now lives full-time in Sarasota.) The second and more fundamental obstacle was that the Russians themselves had not yet mastered the process. In fact, the machines did not reliably produce diamonds.

The General and his newly minted Gemesis needed help. He turned to Iranian crystal expert Reza Abbaschian, head of the University of Florida's materials science department in Gainesville. Abbaschian agreed to try turning the Russians' hit-or-miss method into a rigorously controlled and more reliable technological process. With the aid of some graduate students, he ripped out the analog knobs and dials and installed a computer control system. They upgraded the power supply and methodically tracked the slightest variation in each diamond synthesis attempt. With more than 200 parameters to control, it was painstaking work, and by 1999 – three years after Gemesis was founded – the General needed another infusion of cash.

fied color, clarity, and size. Now they were being asked to distinguish between man-made and mined. The DiamondSure shines light through a stone and analyzes its refractory characteristics. If the gem comes up suspicious, it must be tested with the DiamondView, which uses ultraviolet light to reveal the crystal's internal structure. "Ideally the trade would like to have a simple instrument that could positively identify a diamond as natural or synthetic," De Beers scientists wrote in 1996, when the company unveiled plans to develop authentication devices. "Unfortunately, our research has led us to conclude that it is not feasible at this time to produce such an ideal instrument, inasmuch as synthetic diamonds are still diamonds physically and chemically."

In the summer of 2001, Abbaschian told the General that they were finally ready to mass-produce diamonds. There was one last decision to make. Each machine was capable of generating a 3-carat yellow stone every three days (colorless takes longer). Given their scarcity, the price per carat was much higher for yellow diamonds – so much higher, in fact, that only the very wealthy could afford them. Plus, colored diamonds have gotten hot in recent years. (J. Lo's engagement

PHOTOS: M. CHRISTINE TORRINGTON, COURTESY PICCIONES JEWELRY, NEWSCOM ring? Pink diamond.) Clarke decided that he'd make the biggest splash by bringing yellows to Middle America. He'd compete on both price – charging 10 to 50 percent less than naturals – and style. And, if he succeeded with the yellow stones, he could transition into colorless.

The diamond industry fought back. Early last year, De Beers began shipping improved, even more sensitive DiamondSure machines to labs around the world. Meanwhile, industry groups led by the Jewelers Vigilance Committee have pressured the Federal Trade Commission to force Gemesis to label its stones as synthetic.

The tussle goes to the heart of the marketing problem for Gemesis or any maker of synthetic gems: How will consumers feel about them? The mystique of natural diamonds is anything but rational. Part of the allure is their high cost and supposed rarity. Yet diamonds are plentiful – De Beers maintains vast stockpiles and tightly controls supply.

Clever marketing may bring buyers around to manufactured diamonds. After all, there's no chance that they are so-called blood diamonds – stones sold by African rebels to fund wars and revolutions. And they aren't under the thumb of an international cartel accused of buying off foreign governments, despoiling the environment, flouting antimonopoly laws, and exploiting mine workers.

In fact, Gemesis is developing a marketing campaign that portrays synthetics as superior to naturals. The General came up with a proposal to brand the company's diamonds "cultured" – a deliberate echo of the designation given to the wildly successful (and more valuable than natural) cultured pearl. In an ambiguous April 2001 ruling, the Federal Trade Commission said that it was "unfair or deceptive" to call a man-made diamond a "diamond," but offered no opinion on the question of calling it a "cultured diamond."

So, for now, Clarke is sticking with cultured. But in the end, he insists, it won't really matter. "If you give a woman a choice between a 2-carat stone and a 1-carat stone and everything else is the same, including the price, what's she gonna choose?" he demands. "Does she care if it's synthetic or not? Is anybody at a party going to walk up to her and ask, 'Is that synthetic?' There's no way in hell. So I'll bite your ass if she chooses the smaller one."

> "Give her identical 1-carat and 2-carat stones. I'll bite your ass if she chooses the smaller one."

Wrong, says Jef Van Royen, a senior scientist at the Diamond High Council, the official representative of the diamond industry in Belgium. "If people really love each other, then they give each other the real stone," he says, during an interview at council headquarters on the Hoveniersstraat in Antwerp. "It is not a symbol of eternal love if it is something that was created last week." So goes the De Beers-backed line. And forget the cultured pearl comparison, Van Royen says. Man-made diamonds are more like synthetic emeralds, introduced in large quantities in the mid-'70s. At first, their price was very high, but then the gem labs discovered that the synthetics could be easily distinguished using a standard microscope. The price collapsed and is now less than 3 percent of naturals.

Van Royen is confident the council's lab can pick out synthetic stones. To test him, I ask him to look at a half-carat light yellow Gemesis diamond. A jovial, bearded man prone to nervous laughter, Van Royen takes the rock and peers at it through a 10X jewelers' loupe. "It is very pretty," he admits, giggling. "But so is cubic zirconium." Although Van Royen's lab is outfitted with DiamondSure and DiamondView machines (the Diamond High Council works closely with the Gem Defensive Programme), he instead puts the gem into a more elaborate piece of equipment – a Fourier transform infrared spectrometer that registers the diffusion of light through crystal. Above the machine hangs a large printout that shows six sets of graphs. Van Royen points to one with a distinctive spike toward the right end of the horizontal axis. "If it is synthetic, it should look like this," he says. Sure enough, the machine displays a graph just like the one Van Royen indicated.

But such high-end testing is far from the last word. Only a small percentage of larger diamonds are lab-certified – though the number seems to be growing as the industry becomes more aware of synthetics. Diamonds that are smaller than a fifth of a carat are almost never sent to labs, since the cost would eat up any profit made from them. These modest stones actually represent a significant portion of the market, since jewelry designers regularly use them to create sparkling fields of diamonds on watches, earrings, rings, and pendants. Almost all diamonds of this size are bought, processed, and sold by Indians based in Antwerp and Bombay.

One such group – headed by the Choksi family – bought a $35,000 batch of preliminary Gemesis research stones last year and is currently selling them in India at a 10 to 20 percent profit. I met Sabin Choksi, one of the company's principals, at a jewelry convention in Las Vegas. He admitted that his customers don't know the stones are synthetic, but says they don't care one way or the other. In other words, Gemesis may be fully disclosing the nature of its stones, but already one of its wholesalers is not.

In Antwerp, Van Royen tells me of another threat. There's a rumor of a new, experimental method for growing gem-quality diamonds. The process – chemical vapor deposition – has been used for more than a decade to cover relatively large surfaces with microscopic diamond crystals. The technique transforms carbon into a plasma, which then precipitates onto a substrate as diamond. The problem with the technology has always been that no one could figure out how to grow a *single* crystal using the method. At least until now, Van Royen says. Apollo Diamond, a shadowy company in Boston, is rumored to be sitting on a single-crystal breakthrough. If true, it represents a new challenge to the industry, since CVD diamonds could conceivably be grown in large bricks that, when cut and polished, would be indistinguishable from natural diamonds. "But nobody has seen them in Antwerp," Van Royen says. "So we don't even know if they are for real."

I take a transparent 35-millimeter film canister from my pocket and put it on the table. Two small diamonds are cushioned on cotton balls inside. "Believe me," I say, "they're for real."

Three days before traveling to Belgium, I had flown to Boston to meet Bryant Linares, president of Apollo Diamond. Linares has been secretive about his company and was suspicious about me. He checked to make sure I was really working for *Wired* by calling my editor,

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←105 and he wouldn't say where his company was located other than to tell me to fly to Boston and wait for him at baggage claim.

When I arrive, a preppy, square-jawed man approaches me.

"I'm Bryant Linares," he says. "Follow me."

We get in his blue Saab and begin driving. In a half hour, I realize I'm seeing the same scenery. I ask if we're driving in circles. "We're not taking the most direct route," he allows. For 45 minutes, he questions me about stories I'd written. Finally he seems to decide I'm not a De Beers spy. "You're OK," he says. "There's no need for a blindfold."

We pull up at a suburban strip mall occupied by a fitness gym and a graphic design company. Linares leads the way into the graphics firm's reception area, which looks normal enough. But when he opens one of the interior doors, I catch a glimpse of a man dressed head to foot in Intel-style clean-room scrubs.

"Welcome to Apollo Diamond," Linares says, waving me inside and quickly shutting the door. He hands me a bunny suit, including booties, goggles, and a hair cap, and leads me into a third room. Three men dressed in similar contaminant-control outfits stand around a cylindrical contraption that looks like a heavy-duty coffee urn outfitted with a bolt-on porthole. A preternatural purple-green glow emanates from the window.

I peer through the glass. Four diamonds are growing beneath a shimmering green cloud. "It took me a long time to get to this point," says one of the men standing beside the machine. This is Robert Linares, Bryant's father. In the 1980s, he was a well-known researcher in advanced semiconductor materials. His company, Spectrum Technology, pioneered the commercialization of gallium arsenide wafers, the microchip substrate that succeeded silicon and allowed cell phones to become smaller and handle more bandwidth. Linares sold the company to PacifiCorp, a diversified utility, in 1985 and disappeared from the semiconducting world.

It turns out he took the money and built a secret diamond research lab. "I knew diamonds were going to be the ultimate semiconductor at some point, but everybody thought it was impossible at the time," Linares says. "I had the freedom to do what I wanted after I sold my company, so I spent almost 15 years researching on my own."

To grow single-crystal diamond using chemical vapor deposition, you must first divine the exact combination of temperature, gas composition, and pressure – a "sweet spot" that results in the formation of a single crystal. Otherwise, innumerable small diamond crystals will rain down. Hitting on the single-crystal sweet spot is like locating a single grain of sand on the beach. There's only one combination among millions. In 1996, Linares found it. This June, he finally received a US patent for the process, which already is producing flawless stones.

By January, Apollo plans to start selling them on the jewelry market. But that's just the first step. Robert and Bryant Linares expect to use revenue from the gem trade to fund their company's semiconductor ambitions. Not surprisingly, the diamond industry is hostile to the idea, as the younger Linares discovered four years ago when he attended an industry conference in Prague. He was hoping to find out whether any other researchers – possibly De Beers scientists themselves – had discovered the sweet spot. During a break in the conference, a man approached Linares and told him to be careful. "He said that my father's research was a good way to get a bullet in the head," Linares recalls.

The diamond industry is in fact even more concerned about gems made using chemical vapor deposition than it is about Gemesis stones, though Gemesis poses a more immediate threat. The promise of CVD is that it produces extremely pure crystal. Gemesis diamonds grow in a metal solvent, and tiny particles of those metals get caught in the diamond lattice as it grows. CVD diamond precipitates as nearly 100 percent pure diamond and therefore may not be discernible from naturals, no matter how advanced the detection equipment.

But the greatest potential for CVD diamond lies in computing. If diamond is ever to be a practical material for semiconducting, it will need to be affordably grown in large wafers. (The silicon wafers Intel uses, for example, are 1 foot in diameter.) CVD growth is limited only by the size of the seed placed in the Apollo machine. Starting with a square, wafer-like fragment, the Linares process will grow the diamond into a prismatic shape, with the top slightly wider than the base. For the past seven years – since Robert Linares first discovered the sweet spot – Apollo has been growing increasingly larger seeds by chopping off the top layer of growth and using →

CRAIG MAXWELL

Return to Sender

The Wired "Return to Sender" Contest

Official Rules (See page 19.)

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Entries for the December issue must be received no later than September 2. One winner will be chosen based on the most unusual entry on or about September 10. One entry per person permitted. All entries become the property of the sponsor and will not be acknowledged or returned. All decisions by the judges are final. Grand prize: one (1) *Wired* T-shirt (approximate retail value $30). Void in Puerto Rico, the Canadian province of Quebec, and where prohibited. Subject to all federal, state, local, and provincial laws and regulations. Income and other taxes, if any, are the sole responsibility of the winner. No substitution for prize except by the sponsor, in which case a prize of equal or greater value will be substituted. Prize is not transferable. Winner may be required to sign an Affidavit of Eligibility and Liability/Publicity/Permission release within 14 days or an alternate winner may be chosen.

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For the name of the grand-prize winner, send a self-addressed, stamped envelope to Wired "Return to Sender" Contest Winner (December), 520 Third Street, 3rd Floor, San Francisco, CA 94107-1815, after September 10.

Colophon

Season premieres that helped get this issue out: *Doggie Fizzle Televizzle*; early Indian summer; the return of Lazy Fighter; SJP on *SATC*; freshly stained boxers on *Blind Date Uncensored*; Skinemax; Christianity on *America's Next Top Model*; *World Poker Tour*; *Ren & Stimpy* on the new TNN; very gay Tonys; watching *World's Sexiest Commercials* at the gym; the Apple Power Mac G5.

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← that as the starting point for the next batch. At the moment, the company is producing 10-millimeter wafers but predicts it will reach an inch square by year's end and 4 inches in five years. The price per carat: about $5.

Back at the Diamond High Council, I open the film canister and shake the Apollo stones onto the table. Van Royen tentatively picks one up with a pair of elongated tweezers and takes it to a microscope. "Unbelievable," he says slowly as he peers through the lens. "May I study it?" I agree to let him keep the gems overnight. When we meet the next morning in the lobby of the High Council, Van Royen looks tired. He admits to staying up almost all night scrutinizing the stones. "I think I can identify it," he says hopefully. "It's *too* perfect to be natural. Things in nature, they have flaws. The growth structure of this diamond is flawless."

Van Royen reluctantly hands the diamonds back. "You have something that nobody else in Antwerp has." he says. "You should be careful – somebody might jump out of the shadows with a mask on." He leans in conspiratorially: "If you want to know how important these diamonds are, talk to Jim Butler with your Navy. He is the man."

Jim Butler is the head of a project known as Code 6174 – the Navy's diamond research arm, which is housed in a guarded facility outside Washington, DC. A civilian scientist, Butler has been been researching CVD diamond and semiconducting for the military for 16 years, long enough to see plenty of failure in the field. But today, he's more optimistic than ever. There have been three long-standing roadblocks to diamond semiconducting – and each of them appears to be on the verge of falling. First, diamond is viewed as wildly expensive, due to the artificial scarcity that De Beers maintains with its lock on the market. Synthesized diamonds created outside of the cartel will greatly reduce that problem. Second, there has never been a steady and dependable supply of large, pure diamonds. You can't depend on mined diamonds, as there is no way to ensure that each stone will have the same electrical properties as the next. Apollo's CVD diamonds solve that.

The third big challenge has been the most daunting for materials scientists: To form microchip circuits, positive and negative conductors are needed. Diamond is an inherent insulator – it doesn't conduct electricity. But both Gemesis and Apollo have been able to inject boron into the lattice, which creates a positive charge. Until now, though, no one had been able to manufacture a negatively charged, or n-type, diamond with sufficient conductivity. When I visit Butler in Washington, he can barely contain his glee. "There's been a major breakthrough," he tells me. In June, together with scientists from Israel and France, he announced a novel way of inverting boron's natural conductivity to form a boron-doped n-type diamond. "We now have a p-n junction," Butler says. "Which means that we have a diamond semiconductor that really works. I can now see an Intel diamond Pentium chip on the horizon."

Still, Butler is frustrated with what he thinks of as myopia in the US computer business. "Europe and Japan have been investing in diamond semiconductor research," he says, citing the Japanese government's announcement in December that it would begin allocating $6 million a year to build a first-generation diamond chip. "Bob Linares has given the US the advantage, but nobody's paying any attention," he says. "If we're not careful, the Japanese or the Europeans are going to claim the diamond niche."

Indeed, Intel's top materials executives weren't aware of the latest research breakthroughs when I spoke to them in June, although they certainly understood the potential for diamonds in computing. "Diamonds represent a seismic change in semiconductors," says Krishnamurthy Soumyanath, Intel's director of communications circuits research. "It takes us about 10 years to evaluate a new material. We have a lot of investment in silicon. We're not about to abandon that."

But someday, that's exactly what chipmakers will be forced to do. Just ask Bernhardt Wuensch, an MIT professor of materials science. "If Moore's law is going to be maintained, processors are going to get hotter and hotter," he tells me. "Eventually, silicon is just going to turn into a puddle. Diamond is the solution to that problem."

THE DE BEERS LINE: "IT'S NOT A SYMBOL OF ETERNAL LOVE IF IT WAS CREATED LAST WEEK."

The JCK Show is one of the biggest events in the jewelry business. It draws every major diamond dealer in the US, most of whom buy their goods from De Beers. This year, for the first time, the General tried to get a booth. He was told that he'd applied too late. He suspected that the industry simply didn't want him there, but he took it gracefully and announced that Gemesis would unveil its stones at a smaller satellite convention down the street.

I head to Las Vegas to check it out. The Gem and Lapidary Dealers Association Show is held in a large room at the back of the Mirage. Here – amid purveyors of quartz-encrusted, electric-powered water fountains ("Be amazed by their magic!"), Lithuanian amber salesmen, Nigerian tanzanite dealers, and Vegas-style cowboys in ostrich skin boots – is the Gemesis booth, which displays more than 1,000 carats of yellow diamonds. The show ends tonight, and JCK starts tomorrow morning, so the last few hours see a whirlwind of recently arrived JCK-bound buyers. Efraim Katz, a yarmulke-clad, heavily bearded gem wholesaler from Miami, literally jogs through the room but pauses in front of Gemesis.

"Diamonds mined in Florida?" he asks a Gemesis rep. "I can't believe it. Give me your number – I will be calling."

Kevin Castro, a jeweler in Cedar City, Utah, comes to a surprised halt. "These are awfully pretty," he says.

I tell him that they are man-made and ask if that bothers him.

"If you go into a florist and buy a beautiful orchid, it's not grown in some steamy hot jungle in Central America," he says. "It's grown in a hothouse somewhere in California. But that doesn't change the fact that it's a beautiful orchid."

"Do you care that it's not from De Beers?" I ask.

"De Beers?" he says. "Nobody cares if it's from De Beers. My clients just want a nice diamond." ■ ■ ■