IB Interviews

A Conversation with John Bissell

John Bissell

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O rigin Materials (West Sacramento, CA) was founded in 2008 on the belief that how the world generates the materials it needs has to be revolutionized if humanity is to prevent the looming existential crisis of climate change. Because incremental improvements will not be sufficient, Origin Materials products must fulfil three ambitious requirements: be carbon-negative enough to solve for climate, flexible enough to transform many industries, and economically sustainable.

Toward this end, Origin Materials has spent the last thirteen years developing a platform for turning the carbon found in biomass into chloromethylfurfural (CMF) and hydrothermal carbon (HTC). These chemically flexible intermediates can be used to create many different products used in everyday life, including Origin's first target molecule—polyethylene terephthalate (PET), a widely used material due to its beneficial properties with the largest and most established recycling infrastructure. Through the NaturALL Bottle Alliance research consortium, Origin Materials has strategic relationships with three of the world's largest buyers of PET—Nestle, Danone and Pepsi. To fund scale up, the company announced in February 2021 that it would merge with Artius, a publicly listed special purpose acquisition company with \$725 million in trust.

Industrial Biotechnology sat down with Origin Materials cofounder and co-CEO John Bissell to discuss the company's outlook and strategy as well as the coming revolution in materials.

IB: *What makes this the right time to go public?*

JOHN BISSELL: The driver for us to go public is access to capital. It's as simple as that. The reason why it makes sense to get the capital now is because we're seeing an overwhelming demand for carbon-negative materials. The level of urgency that we see in the market is huge. And it's accelerated dramatically over the last 12–18 months. That means we have to build the capacity, and we need capital to do that.

IB: *Can you discuss the HTC and CMF platform molecules and your commercialization strategies?*

BISSELL: CMF is a really interesting molecule. In the academic literature, people have been looking at HMF [5-hydroxymethyl furfural] for a long time as an attractive furan intermediate. But,

the reality is that CMF can do most of the same stuff that HMF can but can be produced way more efficiently for a variety of technical reasons. We see CMF as the path into furanics and the way to get the full manifold of those products.

CMF comes from the C6 sugars. HTC is really the amalgamation of all the other stuff. The lignin ends up in there, as do decomposition byproducts from the C5 and C6 sugar chemistry. HTC is almost like a nanostructure. It's pretty consistent, with 25–50 nm diameter nanospheres that are all clustered together. Depending on the application we put it in to, we think of it like a highly surface-functionalized carbon black material. It looks like used coffee grounds on a macroscopic scale.

How much of each coproduct is made depends a little bit on which feedstock you're using. If there's more lignin or less C6, then that's going to lean output toward HTC. If you have more C6 sugars in there, you're going to get more CMF.

IB: *Can you discuss the NaturALL Bottle Alliance and what participation in the project has taught you about the technology and market development for bioplastics?*

BISSELL: The NaturALL Bottle Alliance is a way for us to bring together all of our large, early customers to work together to build up the supply chain and deploy the technology initially. It keeps us all tightly coordinated.

It has shown us a few things. First, that these companies are incredibly earnest about their desire to get these technologies to scale. I think they have deployed really significant resources internally to help drive this process. It's not just writing a check and walking away. There are many parts of the alliance that are engaged actively with us on a regular basis. I think the second thing we've learned is that there is a lot of coordination required beyond technology. Even for something well-established like PET, you've got to get all the pieces put together in your value chain. And I think it makes a huge difference to coordinate it with the end customers instead of just treating it like a cog in this system.

IB: *You put your addressable market at \$1 trillion. Can you talk about which markets you are prioritizing in the near term, and why those markets are the most attractive?*

BISSELL: We're prioritizing PET in the near-term, mostly just because there's no market risk. You can drop it in. Customers can use it in their existing supply chain, they don't have to redesign anything or retool anything. That means that we don't have to worry about adoption cycles. Not that there isn't demand for the other products in our pipeline—it just takes longer because there is retooling or capital investment involved. It will just take longer to get them into the market.

We are initially thinking of HTC as an energy source. You can use it as a fuel for power production. There are other applications, but we chose this for the same reason: it's just a drop-in, and there's low market risk. It's not the highest-value application, but it makes it really straightforward to scope the market out.

Some of the other products in our portfolio are different from what people are using today. They might be better than what is on the market today, but there is a cycle requiring some redesign or redevelopment involved. We're really excited about opportunities down the road, including PEF [polyethylene furanoate], epoxies, plasticizers, coatings, and carbon black.

IB: *This philosophy runs counter to many in the biobased products space targeting low-volume, high-margin products instead of pursuing the big, drop-in markets.*

BISSELL: The question there is really one of economics, right? If you have a really low-cost platform, which we do, we get plenty of margin going after a large market like PET. Even if it's not super specialty, niche stuff that's high-value, we get plenty of margin and the scale is attractive.

And, let's be realistic: if your goal is to make an impact—because at the end of the day we are focused on making an impact, not just building an attractive business—picking a target that is 0.1% of the global materials market by volume, and then slowly building a business to get a portion of that 0.1%, is not going to make a massive difference. There's nothing wrong with it. But it's not the way to optimize for impact. From our perspective, building a low-cost production platform is what really lets you go after the high-volume markets. If you have the low cost needed to go after those high-volume markets profitability, then you hit your goal of making an impact.

IB: *How does your technology and market approach differ from previous biobased PET efforts, like Coca-Cola's PlantBottle?*

BISSELL: There are a couple of differences. First, that technology was producing just the MEG [monoethylene glycol], which is not the same part of the PET that we're making. MEG is a much smaller substituent of PET. Second, they were using technology that was early petrochemical-industry technology. It wasn't new technology and there wasn't anything about the technology that the market could do to make that technology economical or interesting. So, I think from a market-building perspective, the market decided that the technology didn't perform well enough to be implemented at scale. It did okay, I don't think it did horrendously. But it wasn't something that was going to radically adjust the economic profile of intermediates produced for the industry.

I think what's different with our technology is that it is genuinely new. This is a differentiated technology that the industry hasn't had access to before. There is a strong supply chain partnership this time around, and there's a lot more pressure from companies to actually reduce their carbon footprint. This technology brings something to the world that wasn't there before, and I think that makes it easier to get traction.

IB: *There is a lot of discussion about the plastics crisis, and the role of recyclability and biodegradability. What are your thoughts, and where does Origin Materials and your renewable PET fit in? And where will PEF eventually factor in?*

BISSELL: Recyclability is extremely important, but biodegradability also has an important role. When materials leak out of our end-of-life-management streams into the ocean or the environment, having those materials be biodegradable is vital. But, the problem with biodegradability is, when that material ends up in it an end-of-life stream, like a landfill or a recycling stream, it can actually cause problems. It is either releasing carbon dioxide or methane, or it may be adding a new plastic that will have to be sorted out. So, biodegradability comes with pros and cons and just has to be used appropriately. There are applications where the pros mean it makes sense, and there are places where the cons mean it doesn't make a lot of sense.

What's important about recycling is it doesn't have the negative emissions profile that you get with biodegradability. And it's a different kind of solution. It's the solution we probably should be using wherever we possibly can. And then in the places you can't you use biodegradability.

That gets to why we think PEF is so interesting. It is both recyclable and degradable. Whenever it gets recycled, it gets recycled, which is the preferred option. Whenever it happens to leak out of the end-of-life-management streams, then it's also degradable, which has massively improved performance with respect to the current plastics out there. You get both.

IB: *Can you talk a little bit about Origin 1 and how that facility will be the springboard for future rollout? And what sort of commitments have you received from partners?*

BISSELL: Origin 1 is under construction right now and will be finished by the end of next year. We talk about its capacity in terms of feedstock in. It will consume about 25,000 dry tons a year of feedstock. It's producing thousands of tons of product. It's not producing hundreds of thousands of tons of product, so it's still small relative to the industry. But if you look at some of the other new or renewable materials companies that are out there, it's as big or bigger than even the commercial facilities. It's not a world-scale plant by any stretch of the imagination, but it's decent-sized.

Origin 2 will be the first world-scale project. We're looking at the back half of 2025. We're at the early stages of that project.

And although it is not baked into our current financial forecasts, we would license the technology as well. Most of the technologies in the chemical industry, it usually goes that way. Once a technology matures, it usually makes sense to license it.

And we have \$1 billion in executed offtake agreements in our backlog. We're accumulating more every quarter. We have a little less than 10 contracts representing that billion.

IB: *The old plastics industry wisdom was to save a tree by using plastics. Why do you consider timber a sustainable feedstock?*

BISSELL: If you look at the timber industry as a whole—sustainable harvesting and more broadly forest products—and

track the carbon impact of using those feedstocks, reality is that if you do it properly, forest products have a way, way lower carbon footprint than using fossil sources. It matters which forest products you're using, and it matters where the forest products are coming from. Just like anything else, you have to do it right and you don't get it all for free. But, I think, generally speaking, the wisdom from the 1970s and 1980s not to use trees was dead wrong.

IB: Can you give IB's readers a SWOT analysis for Origin?

BISSELL: Strengths would be low cost of production, low carbon footprint, and very flexible chemical intermediates. CMF and HTC can make a lot of stuff. The platform can be compared to ethylene, in that sense. Opportunities for us are functionally advantaged products and the huge upswell of demand for low-carbon and carbon-negative alternatives. We haven't even seen any legislation really hit yet but the market is maturing around net zero solutions. Since there is more demand than there is supply for carbon-negative solutions, it will be a favorable environment.

Threats for Origin are not really Origin-specific. I think it's more specific to materials and chemicals. In the 1940s, 1950s, and 1960s, the average consumer understood that materials mattered to them and their life. And I think they kind of don't now. We as an industry need to figure out how to explain to consumers that materials matter in their life, they matter in their political objectives and concerns over climate change, and that if we don't get the materials right, it is hard to have both high-quality products and a low-carbon world. Materials have sort of faded into the background and I think that's bad.

I would say our weakness is that we are at an earlier stage than a chemical giant. The chemical industry is very mature. BASF's maintenance capital spend is larger than our new deployment. But I can spin that as an opportunity as well; if these guys are committed to their existing ways of doing business, and many of them are, then that's an opportunity for a company like us.

IB: The push for sustainable solutions has revitalized interest in biobased products. Do you think the consumer pull will be strong enough to create more commercial successes this time around?

BISSELL: I think one of the mistakes the industry made before was focusing on the "bio" part, which I think is pretty irrelevant. I think it's a red herring. As an industry, I think we got that wrong. The biodegradability piece is interesting because it's a unique feature specific to bio, but bio is just a way to accomplish something, specifically a lower carbon footprint. Whether you are getting a lower carbon footprint because you're sequestering carbon dioxide out of the air and incorporating it into a product somewhere, or you're getting a lower-carbon footprint because you are using a biobased feedstock, I don't think it really matters. What matters is that you have a lower carbon footprint.

I think if you broaden the aperture to low-carbon materials and processes, the level of demand for that is incredible, and the amount of capital that is being deployed dwarfs what was deployed in 2007, 2008. I think in many ways this is the Web 2.0 moment of what I'll call decarbonized industrial materials. So not quite a rebranding, but I think the language should focus on the thing that's actually being fixed.

IB: Origin was founded in 2008—this has been a long road for you. How did you survive the years where investors were wary of biotechnology and how have you seen brand owner commitment evolve in the ensuing 13 years?

BISSELL: We were a really young company when that cycle was happening. We didn't have the same capital demands at that time. That changed the experience quite a bit as opposed to some of the bigger guys who were trying to get projects done back then.

The second thing was that we got to watch them. I walked through a ton of the plants from that era and we got a pretty good feel for what went right and what went wrong. And there were definitely things that went right and there were definitely things that went wrong.

From our perspective, we were a little bit off-cycle in terms of capital raises. The world wasn't swimming in capital for the sector, but there's money for companies that have good technology and demand for their products. But what we really tried to do was learn from the industry during that time.

IB: Brand owners are making aggressive renewability and recyclability targets, some with just 9 years to accomplish. Looking at the market today, and what you know about optimizing and scaling technology: are they achievable?

BISSELL: I think individual companies are probably going to be able to achieve it if they are aggressive. As far as I can tell, I think it's possible for some making claims for 2040, because there's time to scale and make the necessary impact. If they're trying for 2030, it's a stretch. Capital projects take five years typically. The scale requirements are incredible; there are probably hundreds of plants required to deliver on all the net zero commitments being made by brand owners. I think it's probably unrealistic to think they're all going to be able to satisfy their commitments by 2030. But I think the 2040 and 2050 targets are more realistic. Some will make it by 2030. There will be enough for a couple of the large companies to do this by 2030 if they are aggressive about obtaining material.

IB: Any closing thoughts?

BISSELL: Materials' end-of-life matters, as does beginning-of-life. And the industry needs to figure out how to talk to the world better.