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NanoKinetix's nanoagent allows faster, cheaper drug making with heterogeneous catalysts

By Russell A. Jackson

Headwaters NanoKinetix, a research lab in Lawrenceville, NJ, says it has perfected a heterogeneous -- or solid form -- catalyst for use in drug manufacturing that makes the process faster and cheaper and that allows filtration of the heavy metal residue that current manufacturing methods using homogenous catalysts leave behind.

The company may, in fact, venture into drug-making itself, an executive tells *NanoBiotech News*. But for now, the plan is to manufacture and sell a catalyst based on the technology to existing pharma companies.

The key, says Bing Zhou, PhD, vice president and chief technology officer at NanoKinetix, is "using nanotechnology and a solid catalyst, rather than mixing liquids as manufacturers now do, to keep more of the heavy metals -- typically palladium, platinum, iridium, rhodium or ruthenium -- out of the product and, therefore, out of a patient's body."

The magic bullet, he says, is a nanoagent he developed that "grabs the catalyst on one side and, on the other, has a functional group to attach to the solid surface" of the compound to be mixed. "It has been applied to petrochemical synthesis," he adds. "In the pharmaceutical arena, it's an extension of our existing technology platform."

Of course, he won't say what the nanoagent is that makes the catalyst perform so well. "It's a non-hazardous material," he tells *NanoBiotech News*. "So it has no environmental issues. And it's similar to food additives, so we know we can safely use it for drug manufacturing."

The strategy, adds Ray Balee, vice president and general manager at NanoKinetix, is to manufacture the catalyst, either internally or with a pharma partner. "That's still to be determined," he says. "We don't see ourselves in the short term making drugs. We talk about it, but our real forte is developing and manufacturing the catalyst."

He estimates the product's market size at some $650 million. "It's big," he comments. "There are different segments to it, but in general it's a good-sized market."

Convincing the market

The challenge, he continues, is "convincing a market that currently uses a homogenous -- or liquid -- catalyst to use a heterogeneous catalyst." Indeed, Zhou adds, "the current pharma industry practice is using homogenous catalysts to make drug molecules. It goes through several steps, and each requires a catalyst that's difficult to separate from the end product. So you often leave metals in the drug molecule. Is that a big deal? The molecules are approved by the Food and Drug Administration. But it's certainly not a good thing that your body may accumulate the metals over time if you take pills every day. That may have health effects. We still don't know. More research needs to be done on that side."

For now, though, there are "a lot of target markets" for the nano-enabled catalyst, Balee says. "The larger-volume applications would be very attractive," he reports, "because they're more concerned about costs. We can also help improve yield." Also, he notes, "there's a big push toward green chemistry -- and that's a good thing for us. The pharma industry is getting a real rap for not being sensitive to high selectivity. It's making too many by-products. By improving selectivity and yield, we can bring some advantage to it."

The "next-generation catalyst," which NanoKinetix has dubbed NxCat, works in the way it anchors the catalyst to the solid material. "That technical know-how is critical because unless you affix the catalyst correctly, you can often produce enough by-product to be toxic," Zhou explains. "Drug molecules are often just slightly different from toxic molecules, and when you anchor the catalyst it can change itself -- meaning you lose the 'activity' element of the process. We have technology that can anchor to a surface but maintain the activity -- and selectivity -- of the catalyst."

How it works

It works like this: "First we select the catalyst," Zhou reports. "It can be an organo-metallic complex commonly used by the pharma industry. Then we mix the catalyst with our nanoagent. Then we deposit the whole complex on a solid surface. After that, the catalyst is anchored to the surface. When used for drug synthesis, the anchored catalyst can be physically filtered out from the drug molecule. When you check the final product in solution, you can't even detect the metal."

Part of what makes the nanoagent work, he continues, is it allows researchers to adjust the distance between the catalyst and the solid support material. "Most research that has tried to anchor a homogenous catalyst to a solid couldn't adjust that distance, so the catalyst was affected by the solid material," he says. "That's when it loses activity and selectivity. They can anchor it, but not in a controlled way. But we can adjust the distance from 1 nm to 30 nm, so the catalyst is free to maintain activity and selectivity."

Overall, he adds, "our nanotechnology has four critical features and, for catalysts to be successful, all four must be present." First, you need to control the catalyst particle size, he explains. "Without the correct particle size, you may not get the reaction you want. A good example is synthesizing hydrogen and oxygen. If you have 4 nm catalyst particles, you make hydrogen peroxide. But if you have 2 nm particles, you make water." Also, he continues, "if you deposit a catalyst on a solid surface, its molecules may cluster, meaning you lose activity. But we can individually expose the catalyst particles."

The second feature, he continues, relates to the fact that a catalyst often is not just one metal. "Our technology can control it to each nanoparticle with a specific composition," he says. "If you need more than one metal for the required reaction, you can control it to put one to one or one to a higher ratio and make each particle with precision. Others can't do that. They can 'macro-control,' and they often have individual particles, but they can't make all nanoparticles with multiple metals."

The third factor, he goes on, involves the specific structure of the catalyst. "If you don't control it when you deposit it on the solid surface," he notes, "that structure will change -- and structure is important to selectivity." Also, he re-emphasizes, the most important factor is the NanoKinetix nanoagent anchors the catalyst in a way that allows control over the distance between it and the solid surface.

Those factors, he stresses, help his process lower drug-making costs. "If you have a catalyst that adds too much to the cost," he points out, "no one will use it. But our nanoagent is cost-efficient and does not affect the end product. We are not using technologies that you can't mass produce with. We're using a chemical complex that is cost-efficient to control the catalyst's structure, composition, particle size and stability. That's why we are economically feasible for pharma use."

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