# Tailoring fungi-based biofuels to meet the needs of current, advanced combustion engines

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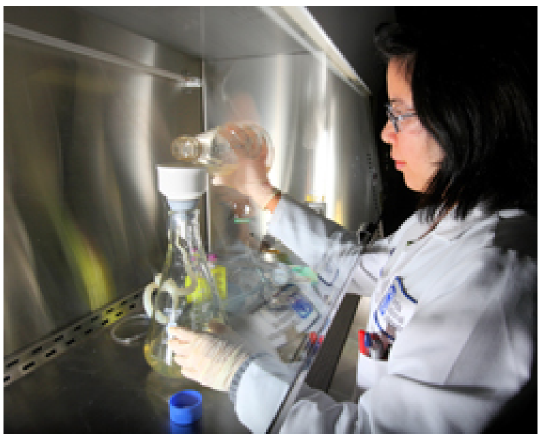

Sandia researcher Eizadora Yu prepares biomass harvested from liquid fungal cultures for nucleic acid analysis. The cultures come from the endophytic fungus Hypoxylon sp, which produces compounds potentially used for fuel. Credit: by Dino Vournas

(PhysOrg.com) -- Engine experts and biofuels researchers at Sandia National Laboratories are working on a project that aims to modify an endophytic fungus so that it will produce fuel-type hydrocarbons for transportation purposes.

The biofuels being investigated for the project are produced by a class of fungi -- endophytes -- that live between plant cell walls. The cellular material in plant walls can be converted into hydrocarbon compounds that work well as fuels for internal combustion engines. Sandia is collaborating with Professor Gary Strobel from Montana State University, a known expert in *Ascocoryne sarcoides* and other similar fungi.

The beauty of the endophytic fungi, Sandia biochemist Masood Hadi said, is that there is no need for the cost-intensive industrial processes that are typically required to break down biomass. “These things can turn crystalline cellulosic material directly into fuel-type hydrocarbons without any mechanical breakdown,” he said.

These fungi, in other words, are designed by nature to grow on cellulose and to digest it, forming fuel-type hydrocarbons as a by-product of their metabolic processes. Through genetic manipulation, the Sandia team hopes first to identify these pathways, and then to improve the yield and tailor the molecular structure of the hydrocarbons it produces

## Finding a fuel-friendly mix of molecules

Sandia’s bioscience team is using genetic sequencing to catalog the pathways and other molecular biology techniques to understand how changes in feedstock determine the type and amount of hydrocarbons the fungi make, with a long-term goal of engineering greater quantities of the desirable fuel species. Meanwhile, Craig Taatjes and John Dec, both engine combustion researchers at Sandia, are experimenting with the main compounds produced in the molecular “soup” and give feedback to their bioresearch counterparts on their ignition chemistry and engine performance. The ideal outcome, Dec said, is to “dial in” the right feedstocks combined with the right set of genes to produce the preferred blend of compounds to go into an engine.

The first step has been to learn what kinds of compounds the fungus makes naturally on its own. “We just don’t know much about some of the compounds, so we need to do research on their ignition chemistry and how they behave in an engine,” Taatjes said. The team, he says, is working with Professor William H. Green at the Massachusetts Institute of Technology to develop an ignition chemistry model that can predict the performance of the classes of compounds made by the fungus.

Hadi and his colleagues are doing their part to build up the understanding of the distribution of molecules produced by the various fungi, at which point they can genetically tailor them to produce more of the “right” kinds of compounds that suit the needs of engine combustion.

Eventually, the team anticipates that enough hydrocarbons will be extracted from those produced by the fungus to test in the lab, or even in an engine. “We hope, in the end, to have a biofuel that was developed in conjunction with the development of the combustion model for that biofuel,” Taatjes said.

Dec, who runs the Homogeneous-Charge Compression Ignition (HCCI) lab at Sandia, said experiments on the HCCI platform offer good fundamental information on fuel auto-ignition behavior that can be related to performance in other engine types, such as spark-ignition or diesel, as well as to performance in HCCI engines.

## Engine, biofuels collaboration a no-brainer

Taatjes, Dec and Hadi all agree that it makes perfect sense for Sandia to invest in a project that focuses on an engine’s interaction with a new biofuel.

“Any fuel that’s going to make it in the marketplace is going to have to blend with gasoline,” Dec said. “A new biofuel, whether it comes from the Ascocoryne fungus or another source, will be more useful commercially if we have first learned how it will affect combustion processes," Hadi added.

Another aspect of this project, Taatjes said, is that the biofuels researchers are working directly with the combustion experts to understand from the start just what will work best as fuel for internal combustion engines, accelerating the pace of alternative fuel development and the associated engine optimization. "We have a rare opportunity to decide ourselves what the fuel is going to look like and can build our own optimization loop," he said.

"There is a whole new range of potential fuels now with biomass," Dec said. "The new fuels will have to work well with both existing engines and advanced engines, like HCCI or low-temperature diesel combustion. Only then will you be able to sell the fuel at the pump and get your new high-efficiency, low-emissions engine into the marketplace."

Provided by Sandia National Laboratories

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