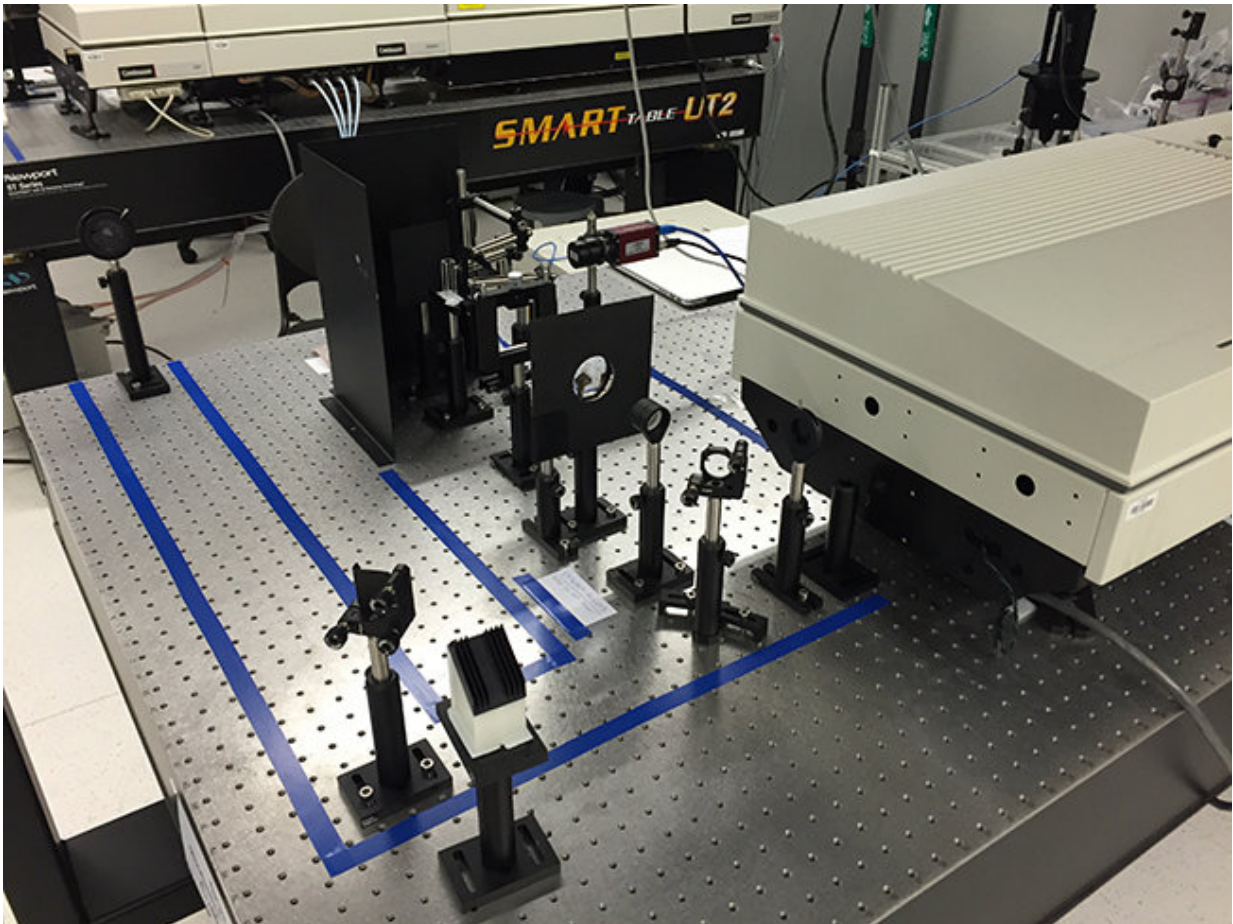


Renewables could drastically cut tailpipe emissions

August 14 2018

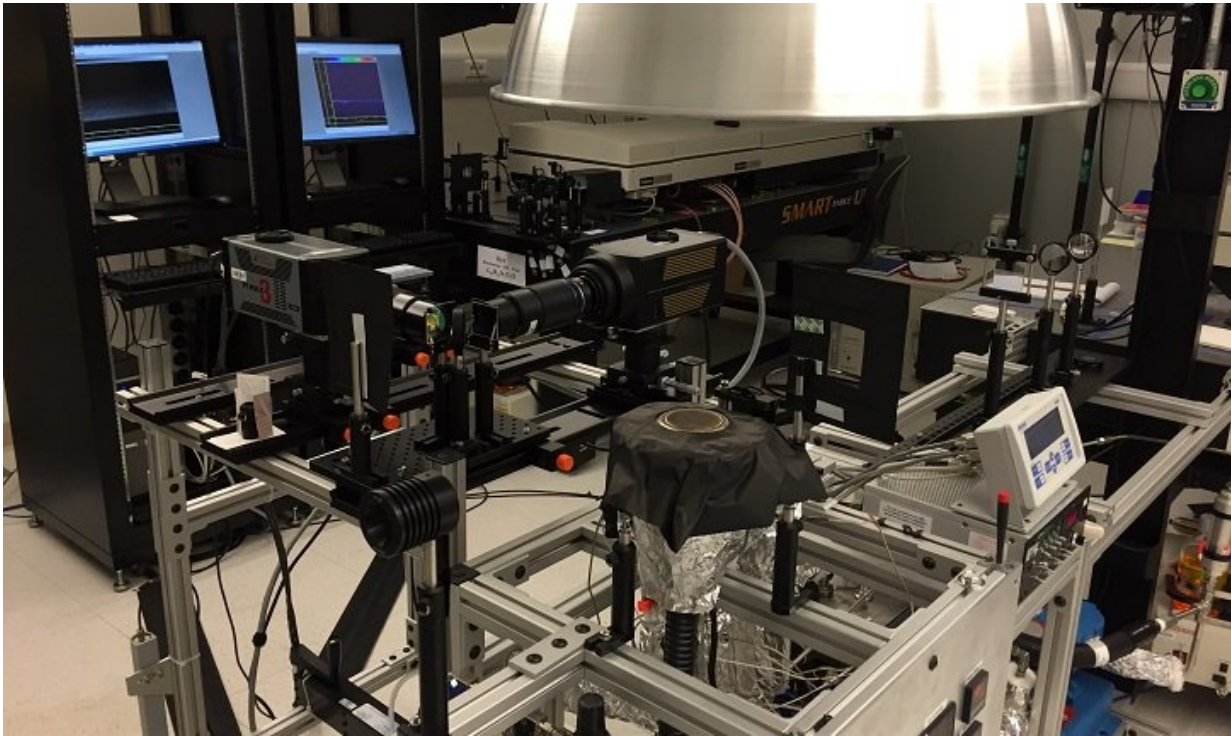


A complex set-up of lenses and cameras are required for direct, laser-based NO_x measurements in a flame. Credit: © 2018 Miles Bohon

Switching to renewable fuels could significantly lower exhaust emissions of toxic nitrogen oxides (NO_x) as well as curbing global greenhouse gas emissions. Researchers at KAUST have combined computer analysis with laser-based NO_x concentration measurements to understand NO_x production pathways in different fuel types. The results may inspire new ways to mitigate NO_x emissions, the researchers say.

Long before climate change focused global attention on vehicle carbon emissions, regulators were clamping down on NO_x because of its detrimental effect on air quality. "Controlling nitrogen-oxide emissions continues to be a real challenge, with ever tightening restrictions on automobiles, trucks, and aviation," says William Roberts, who directs the KAUST Clean Combustion Research Center. "We are continually looking at emerging fuels and trying to develop chemical kinetic mechanisms to predict NO_x formation."

In the latest study, Roberts and his colleagues examined NO_x emissions from alcohol fuels, such as ethanol. These [renewable fuels](#) have gained attention because they are potentially carbon-neutral, but they also produce lower NO_x emissions than conventional fossil fuels. Nitrogen oxides can be produced by various pathways, each of which dominates a different stage of combustion, says Myles Bohon, who contributed to the study during his Ph.D. before joining Technische Universität Berlin. "By understanding these pathways and their relative importance, it becomes easier to develop NO_x mitigation techniques," Bohon says.



The set up used to calibrate the laser beam. Credit: © Myles Bohon

The researchers used planar-laser-induced fluorescence (PLIF) to measure NO_x production throughout the flame, comparing alcohol fuels with an alkane fossil [fuel](#) surrogate. The technique helped the team differentiate nonthermal NO_x production pathways, which dominate early in the flame, from thermal NO_x production pathways, which mainly occur in the high-temperature post-flame region.

"These types of direct measurements are pretty difficult to pull off," says Bohon. "But they are important because they directly show the differences in the nonthermal NO formation between the two fuel classes." As much as 50 percent less nonthermal NO was produced in the alcohol flames, the researchers observed. They also developed an algorithm to further pinpoint the specific NO_x [pathway](#) contribution

differences between [alcohol](#) and alkane fuels.

"Alcohol fuels definitely have applications in internal combustion engines, where alcohols—ethanol in particular—are added to gasoline," says Bohon. "There is a lot of potential to use fuel blends to mitigate NO_x," he adds.

KAUST researchers are continuing to refine their mechanistic understanding of NO_x production, validating their models using laser-based diagnostics, to "predict, understand and eventually mitigate NO_x emissions," Roberts says.

More information: Myles D. Bohon et al, PLIF measurements of non-thermal NO concentrations in alcohol and alkane premixed flames, *Combustion and Flame* (2018). [DOI: 10.1016/j.combustflame.2018.05.024](#)

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