Software technology that simulates LED devices for rapid development of light sources

March 29 2018

A Purdue-affiliated company is developing a new time and cost effective software technology that could offer a more efficient and realistic way to model and simulate light emitting diodes (LEDs) in order to achieve more powerful and more efficient LED light sources often used in general lighting, automobile lighting and consumer electronics.

Tillmann Kubis, a research assistant professor, and Gerhard Klimeck, a professor, both in Purdue's School of Electrical and Computer Engineering, in Purdue's Network for Computational Nanotechnology and Purdue's Center for Predictive Materials and Devices, along with Junzhe Geng, a graduate student in Klimeck's nanoelectronic modeling group, co-founded the company LEDcentral LLC to commercialize the technology.

LEDcentral's goal is to improve the design of LEDs efficiency and output power.

"The most efficient LED light bulb on the market right now has a rather dim output, so what we are trying to do is develop a way to have high output power and still achieve high efficiency. Right now that is not possible because of what is called the efficiency droop. It's not fully understood where the droop comes from or how to solve it, so that's where our software model comes into play," Kubis said. "Currently, we're specifically interested in blue LED lights, which are the basis for

white light bulbs. We aim for our models to help industry develop more powerful and more efficient LED technology."

LEDcentral's modeling software could save both time and money in the development process.

"Instead of fabricating hundreds of devices, you can simulate thousands of them, and then pick the best 10 you actually care about," Kubis said. "Additionally, if you have experimental data that you don't fully understand, we can explain why the behavior is observed. We are able to explain experiments that have happened and predict experiments that have not. Users can run our technology on a local computer and we also have user interfaces so that it's easy to use for a person who isn't trained in the software."

Kubis said conventional models may be insufficient and expensive.

"The models existing in industry and academia are based on classical approaches where electrons are considered particles; however, their behavior should be studied on a multiscale paradigm, i.e. atomistic resolution on a micrometer length scale," he said. "Models on the nanometer scale do a fairly good job, but important LED properties are missing. Additionally, the attempts to model the physics on a quantum level are usually very expensive. The quantum mechanics are captured and the small scale is fully covered, but these attempts are not very efficient."

It is very difficult for designers in academia and industry to gain a deeper understanding of LED processes to guide design improvements, Kubis added.

"LED devices are small and expensive to make. It's not feasible to make a hundreds of these devices without checking for improvements, because

the physics involved is very non-linear and very complicated," he said. "If a change in the device's structure allows it to perform better, you can't just keep implementing that change and expect it to keep advancing the device. This insight into the physics component can really help guide and advise design improvements."

Technology used by LEDcentral is licensed through the Purdue Research Foundation Office of Technology Commercialization. The company is a member of the Purdue Startup Class of 2017. LEDcentral's software is being used in existing code.

"Our technology has been implemented into an existing software and is currently being utilized. Our method is really efficient and our results have shown that we are very close to the experimental data, closer than any other method developed so far," Kubis said. "We've received very positive feedback so far and found that after receiving real device data that our modelling data was in almost perfect agreement."

Overall, the software could greatly influence the environmental impact LED lights have, Kubis added.

"If we can, with little effort, replace all these inefficient light bulbs, the energy waste could be cut tremendously," he said. "There's a huge environmental aspect to what our technology could do."

LEDcentral plans to release its product in the near future.

"Right now our technology is only available to those using a specific platform which has been commercialized by another company. For public release we've been using nanoHUB quite extensively as it offers online training, seminars, papers, textbooks, presentations and online tools," Kubis said. "Our technology will be part of a tool in a simplified version. This would support our business but also allow students and

classes to benefit from it. Within the year it should be available."

Provided by Purdue University