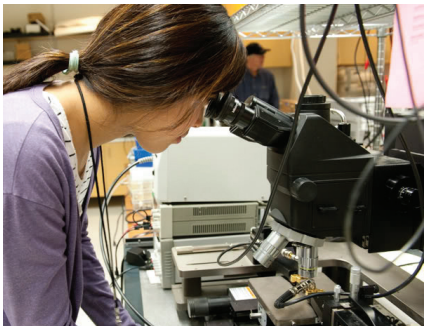
SUCCESS STORY: THE NEXT SEMICONDUCTOR REVOLUTION



Umesh Mishra is at the helm of High Efficiency Power Conversion, one of the hottest innovations in Energy Efficiency

THE SITUATION

Electricity is converted at various stages of its journey to homes, factories, and businesses to meet the needs of the devices it powers. Here's the bad news: More than 10 percent of all power generated in the U.S. is lost in power conversion, acting as a hidden tax we all pay on electricity. These losses add up to over $40B annually and over 300 Terawatt hours (TWH) of electricity energy wasted.

THE CHALLENGE

After electricity is generated, it is transmitted as AC current over high-voltage power lines. It must be converted back to DC current before it can be used in many applications such as data servers and laptop computers. Conversion of power from AC to DC and back to AC is required for applications such as motor drives, air conditioners, etc. DC voltages are connected to AC in applications such as PV inverters and within a hybrid car to use the energy from the battery which is a DC source. Within these applications, electricity is often converted from one voltage level to another. Conversion losses are a significant barrier to adopting sustainable technologies as well, since these losses make solar panels less efficient and electric vehicles heavier. For decades, silicon-based converters, which perform at about 90 percent efficiency, have been the best option, but their progress is slowing. Another technology will be needed to continue these efficiency improvements and keep up with rising electricity demand.

THE OBSTACLES

Institute faculty member Umesh Mishra has been working with a material called gallium nitride (GaN) since 1996. The material has been instrumental in advancing LED technology, but had never been applied to electricity conversion.

"Silicon has reached its limits in power conversion, and literally, silicon has reached its physical limit. We are using gallium nitride to move away from the path set by silicon," says Mishra.

There are two basic requirements for a material that can outperform silicon. First, the material must be able to withstand high power levels. Second, it must have the ability to easily transport electricity. Gallium nitride's ability to accomplish both tasks is what makes it such an exciting advancement.

To create GaN-based convertors, Mishra and colleagues first had to find a substrate that would be compatible with GaN. "You cannot mine GaN. It has to be grown on foreign substrates," Mishra notes. Fortunately, the structures of GaN and silicon are similar enough to be effectively combined.

THE BIG IDEAS

Think small, think light. Previously, there has been a trade-off between efficiency and power density. As a result, devices that maximized efficiency were larger than their counterparts. GaN's unique characteristics allow it to increase both efficiency and power density. This means that the rectangular adapter connected to our laptop cords could shrink or even disappear altogether. Moreover, electric vehicles could be lighter and have smaller batteries, increasing their marketability.

WHAT'S NEXT?

After years of incremental progress, Mishra and his team have developed a gallium nitride convertor that is about 99 percent efficient. Full implementation of GaN electricity convertors could reduce U.S. electricity demand by the equivalent of 300 large coal-fired power plants. "The amount of savings added up is more than all the electricity consumed by the West Coast each year," says Mishra. "That's the scale of the impact."

To take his breakthroughs to the marketplace, Mishra co-founded Transphorm, located in Goleta, California. His team's breakthroughs and the power conversion solutions they can provide are so significant that Transphorm has attracted many investors and international attention.