

PROF. SHUJI NAKAMURA

More Light!

Professor Shuji Nakamura was awarded the 2014 Nobel Prize in Physics and has devoted his entire research career to light. In this essay, he explains why inexpensive light is invaluable.

Finally! The age of incandescent and fluorescent lighting that eats up electricity is drawing to a close. I have spent countless hours of my life developing and researching solid-state light sources – in other words, LEDs and laser diodes. My goal was to provide efficient and custom light sources. So I'm thrilled that light bulbs and fluorescent tubes can now start making their way, slowly but surely, into the collections of technology museums and that the job of bringing light to the world can be given to solid-state lights. The way I see it, cheap light is a driver – or even a measure – of civilization. Can you imagine human civilization without light? Surely our languages, traditions and heritage all stem from a time when, after a day of hunting and gathering, our ancestors would return home and have stories to share by the light of a campfire. That's still true today. Nowadays, poorer societies can skip an entire step in their technological evolution – instead of relying on inefficient lightbulbs, they can go straight to efficient LEDs. And the electricity needed to power them doesn't come from a central grid, but rather from batteries charged by affordable solar cells. Just imagine where this will lead! People will be healthier since they will no longer have to light their rooms with toxic kerosene lamps. School children and adults will finally be able to read and study by night as well as by day. This will considerably improve literacy and the level of education in poorer countries – and with it people's chances for a better life.

The healing power of light

For me, light is also a symbol of life and health. It is a great help to physicians – sometimes letting them see what they need to see. LEDs offer the great advantage that they can be made very small, so that they can be positioned at the tip of tiny handheld surgical instruments. This means that light can be shone precisely were the surgeon needs it and, because LEDs give off very little heat, they can be positioned very close to where the surgeon is operating. In the future, our bodies will be home to more and more artificial materials that have undergone some reaction caused by light. Dentists, for example, model implants out of artificial resin that hardens in seconds when exposed to a certain type of UV light. Even fractures heal faster with the help of photosensitive materials. Light will also help protect us. Colleagues of mine are currently working on UV LEDs that will help us disinfect surfaces. Others are using a certain type of UV light to activate medications the patient has already been given. This means that the medications target the cells or pathogens when and where they're supposed to and

the patient is protected from unwanted side effects. All these applications benefit from our ability to control the wavelength of light from solid-state sources with a high degree of precision.

I regard inexpensive light as a driver and even a measure of civilisation.

Prof. Shuji Nakamura

Finding clever uses for light is also a key factor for success in medical research. The winners of the 2014 Nobel Prize in Chemistry even managed to use light to examine structures and movements that are smaller than half the light's wavelength and make them visible. This work by Eric Betzig, Stefan Hell and William Moerner opened up a type of nanoscopy that allows us to see how molecules form synapses. The technique will help us better understand diseases such as Parkinson's and Alzheimer's. I feel there's considerable room for improving the way solid-state light sources are used in medicine and biology. It should be possible to push wave-lengths even further into the ultraviolet range, which in turn would open up a wealth of potential applications.

Mood lighting

Light will help us to feel better. For a long time now, I've been fascinated by discovering what effect light can have on our moods or, even more so, on our physiology. Any parent living in an industrialized country will know that it's a good idea to send their children outside for some fresh air every now and again. Of course there are a number of benefits to doing this, but one is that our skin needs to absorb UVB rays from sunlight to generate vitamin D. Light also controls our circadian rhythms – in other words, our inner 24-hour clock. We can turn this to our advantage by installing suitable blue light in our offices; this has been shown to improve people's mood and productivity. The lighting in some airplanes is programmed to help passengers experience as little jetlag as possible. In countries with long winters – Sweden, for instance – there are "daylight showers" at bus stops. This kind of simple light therapy has been scientifically proven to have a profoundly positive effect on people's moods. Doctors around the world are using light to treat depression and sleep disorders.



Biography

was born in the southern Japanese town of Ikata in 1954. In 1993, he used indium gallium nitride to develop the first lightemitting diode that could produce super-bright blue light Until that point there was no way to generate the blue color spectrum making it possible for LEDs to emit white light. Isamu Akasaki, Hiroshi Amano and Shuji Nakamura shared the Nobel Prize in Physics in 2014 for their groundbreaking research that led to efficient LED light. Nakamura has been teaching at the University of California in Santa Barbara since 2000.

I take frequent walks in the countryside and find that doing this stimulates my creative process. Once I was thinking about how most of us take light for granted. But what is light? I'm not talking about the age-old debate of wave vs. particle. I'm more interested in what light means to us. For plants, light means food. But for us, light is primarily a way to transmit information – a medium for feeding the mind and spirit. Just look at the words we use: Teachers illuminate their subjects, human understanding of the world exploded during the Enlightenment and the police are tasked with shedding light on situations. Your smartphone's small, illuminated screen uses light to deliver information to your brain. You can tell which sculpture in an exhibition is the most important by how it is lit. The tiny light mounted on the tip of your drill allows you to better see where you are drilling. Light also carries information from a technical point of view: the backbone of the internet is made up of massive fiber optic cables, your Blu-ray player allows you to watch the latest season of your favorite TV show. And LiFi systems are increasingly being used to transmit information across open spaces: a photodiode converts the flashing light of a light diode into electrical impulses. We already have the first LiFi cell phone.

„Toni, turn of that laser and go to sleep“

What will the future bring? More light! We've by no means exhausted the potential of efficient light sources. At the Solid State Lighting and Energy Electronics Center in Santa Barbara, my colleagues and I are working on using lasers in lighting systems. LEDs still suffer from what we call droop – they become less efficient when powered by higher currents. Lasers don't have this problem. This is why we want to use lasers to create a smaller, brighter light source, which means that we'll also be able to simplify the design of the heat dissipater and optics. We hope that sometime in the near future, a mother will be telling her son, "Tony, turn off that laser and go to sleep."



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