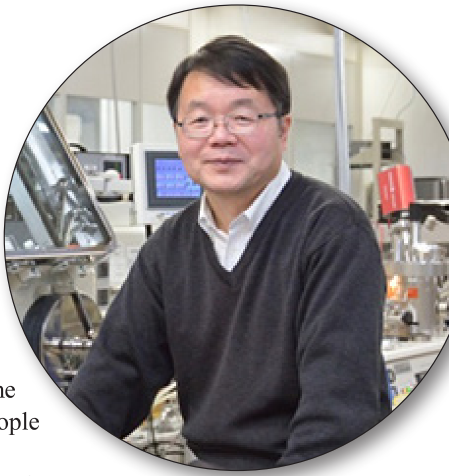
Hideo Hosono

2018 Von Hippel Award winner and passionate materials scientist

By **Humaira Taz**



Imagine getting inspiration for your PhD thesis from the work of *one* scientist, to the point that his work is all that you and your advisor talk about, and then one day getting the opportunity to talk to that person over Skype? That was my star-struck moment when I interviewed Hideo Hosono, the recipient of this year's Marerials Research Society (MRS) Von Hippel Award. Hosono is well known for his work on transparent amorphous oxide semiconductors; he is a professor at the Institute for Innovative Research and the director of the Materials Research Center at the Tokyo Institute of Technology.

Hosono's journey in materials science started with his research on oxide glasses during his PhD studies. When he was a graduate student, amorphous semiconductors, such as chalcogenides and amorphous hydrogenated silicon (a-Si:H), were extremely popular. Hosono hoped to create transparent amorphous oxide semiconductors. Transparent oxides all tend to be insulators. In a-Si:H, a material with covalent bonds, the mobility of electrons was low due to the presence of defects and disorder. So Hosono started thinking about ionic oxides with heavy-metal cations. To him, the system was analogous to amorphous metals, except that in these ionic oxides, the electron cloud of the metal atoms would be replaced by the *s*-orbitals of the heavy-metal cations that have large diameters. The electron mobility in these oxides would thus be high even in an amorphous state.

So how did he come up with the idea? According to Hosono, his research inspiration comes from two sources: "First of all, I wanted to experience the feeling of scales from my eye; this is more of a personal inspiration. But second, I wanted to see the height of products that realize my invention into a day-to-day application." The company LG utilizes indium-gallium-zinc-oxide, one of the members of the transparent amorphous oxide family, to make the backplane for its organic light-emitting diode screens for TVs and smartphones. "I think you can also find it in the display of the Microsoft Surface Pro 4," Hosono added.

Hosono's innovative approach to materials research does not end there. He also discovered iron-based high-temperature superconductors. "Our target was to develop magnetic semiconductors, but in the end, we discovered that the iron- and nickel-based compounds that we were investigating were superconductors!" Hosono reminisced. When asked if it was simply luck, he mentioned that careful observation and characterization of the materials had a lot to do with the discovery. "Systems of iron and oxygen had been examined for more than 20 years, even before we started working on them. However, no one really looked at the conductivity of the iron and prictide systems at low temperatures, and that's where we found superconductivity," Hosono explained. He stresses the importance of interdisciplinary research to make scientific breakthroughs. While Japan has very strong materials research facilities, not a lot of interdisciplinary work takes place. In that regard, Hosono expressed how amazing the MRS is in bringing together people from all scientific backgrounds.

Hosono provided words of advice for young researchers and students: Never focus on what has been discovered already; keep an open mind toward what is still out there waiting to be found. "Many students feel there is no possibility to discover any exciting materials because everything has been found already, but that is not true. There are plenty of interesting materials hidden in plain sight," Hosono said. One shining example is the class of materials called electrides, which Hosono and his team are working on, and which he regards as the most exciting work he has ever done. In electrides, the electrons act as anions (i.e., almost static and localized). C12A7 ($12CaO•7Al_2O_3$) is the main component of cement and typically is non-conducting. However, when this material is doped with electrons, it becomes semiconducting with unique properties, where its work function is as low as that of an alkali metal, and yet it is chemically stable. One of its applications is as a catalyst for ammonia synthesis at mild condition, and a Japanese company has acquired the rights to use it for this purpose. "If you can control the electrical properties of such a cheap and abundant material as cement, then imagine all the inexpensive electronics you could make with it!" Hosono exclaimed.

In addition to his ongoing research projects, Hosono also gives lectures at local high schools about four times a year to encourage students to pursue materials science. "People are still not accustomed to having materials science as a discipline of study, so it is important that young people know all the advances happening in this field," Hosono said.

Through the entire conversation, Hosono was very humble about his accomplishments, explaining every detail of his research that I did not understand in simple terms and with a smile. When I asked about his reaction when he learned of the MRS Von Hippel Award, he said, "I was not only surprised that they had awarded me the Von Hippel Award, because the previous recipients were much more senior, but also that I am the first Japanese person, and one of the few Asian scientists, to receive it in the past 40 years. It is really an honor," he explained.

No better person could have received the award for contributions to the materials research community. If there is one thing I learned from him, it is that great work comes from an open, enthusiastic, and humble mind. □

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