Interview with Prof. Jongwook KIM

"While answering scientific questions, new questions arise, deepening and widening the field you work on." Jongwook Kim

*The interviewee, **Jongwook Kim**, assistant professor at* École Polytechnique *(LPMC, Palaiseau), is a specialist in nanomaterials and their applications, especially in electronics and optic.*
He is a keynote speaker at the thematic session "Nanochemistry & Nanoparticles" of the C'Nano congress 2020.
This interview was carried out as part of the Chemistry Master of Paul Sabatier University (Professionnalisation UE).
*The words followed by an asterisk * are explained at the end of the interview.*

Where did you get this interest in nanotechnology?

My first laboratory research was during my undergraduate study in a university laboratory making nanoparticle-based photonic crystals*. This choice was almost by chance, meeting the laboratory professor who kindly explained his work in a passionate way. It was in the early 2000s, when nanoscience began to attract a huge amount of attention. I also got more interested in it because I found that there were so many uncovered sciences to newly understand, which meant a lot of opportunities for young scientists.

In nanotechnologies, many procedures are involved: synthesis, optimization of the synthesis process, optical analysis (including microscopy), computational analysis, etc. Which one is your specialty, or perhaps your favorite?

My work covers actually most of these procedures except computational studies (that I rather do by collaboration). I am an experimental materials scientist who is a half-chemist (synthesis, post-synthetic chemistry, characterizations...) and a half-physicist (optical analysis, microscopies, applications, making devices...). This is not the common case and it can be quite difficult in terms of management of time and expertise. But it offers more chances to understand better and discover more by mastering the whole process on one's own material. I like all phases and try to become an expert in all.

What is your main research topic today?

Many of the early questions arisen in 'nanoscale' have been answered and theorized during the last decades. Of course, today, there exist as many new questions on the hands of nanoscientists. An interesting point I found is that the classical understandings of the intrinsic properties, already existing in bulk material structures, are often forgotten while we focus on the new nano-properties. I try to redesign nanomaterials for their nano-properties and intrinsic properties to synergistically collaborate to perform the best functionalities. For instance, we can tune the crystal structure of the nanoparticle phosphor which largely improves the efficiency of luminescence maintaining the nanoscale morphological advantage of the particles [1].

[1] Chaudan, E.; Kim, J.; Tusseau-Nenez, S.; Goldner, P.; Malta, O. L.; Peretti, J.; Gacoin, T. Polarized Luminescence of Anisotropic LaPO4:Eu Nanocrystal Polymorphs. *J. Am. Chem. Soc.* **2018,** *140,* 9512-9517.

Has any of your research already found large-scale industrial applications?

The work in the reference [2] is being applied to make commercial electrochromic* smart windows. A startup company, Heliotrope, is now doing commercial application of plasmonic nanocrystal-based smart windows.

[2] Kim, J.; Ong, G. K.; Wang, Y.; LeBlanc, G.; Williams, T. E.; Mattox, T. M.; Helms, B. A.; Milliron, D. J. Nanocomposite Architecture for Rapid, Spectrally-Selective Electrochromic Modulation of Solar Transmittance. *Nano Lett*. **2015,** *15,* 5574-5579.

You have contributed to the development of nanochemistry mainly through electronic devices. Would you like to expand the scope of applications? If so, which application and why?

That is one of the topics that I have worked on. Another axis of my research is on nanophosphors. We are developing luminescent nanocrystals with anisotropic emission properties*. They can be used as bioprobes to measure the orientation dynamics (e.g. rotation) of cells, enzymes, etc. and also for microfluidic analysis by measuring shear-stress* related to the orientation of the nanocrystals under flow.

Nanotechnologies being an emerging field, many economic issues are involved on an industrial scale. In addition, they raise questions about human health and the environment (safety hazards, pollution, etc.). What is your opinion on these issues and how is your research directly concerned?

It is normal that any technology is involved in the economy and industry. For health and safety, scientists do not know all the risks of their materials. As we saw many cases, such as for asbestos*, we should be extremely careful on the unknown impacts of new materials. More support is necessary for research on those issues. Handling the nanomaterials with care in the lab is compulsory. If a material is industrialized and commercialized, a protocol to recollect them after use or in case of spill must be provided.

Would you like to work in another field of nanotechnologies? If so, which one?

The interests naturally evolve continuing the research activity. While answering scientific questions, new questions arise, deepening and widening the field you work on. These days, I am starting medical application of the nanophosphors that I have been developing. I am newly learning the pulmonary system of the human body. It is exciting that we find an unexpected bridge between the fundamental materials research and the popular human diseases. Most researchers will not hesitate to step on such a bridge.

Vocabulary:

* Photonic crystals: periodic structures that modify the motion of photons and can, under certain conditions, block the propagation of light (applications in thin-film optics: coating on lenses and mirrors, color changing paints, inks, etc.)
* Electrochromic material: material that can change color or opacity when an electrical charge is applied
* Anisotropic emission properties: the light is emitted with different intensities, depending of the polarization axes (if the intensities were the same, the emission would be isotropic)
* Shear-stress: stress applied parallel to the material
* Asbestos: mineral fibers that cause inflammation of the lungs (asbestosis). In French: “amiante”.

Interview by Riciga Gnanasegaran, Héloïse Leboucher, Audrey Pougary and Nirina Taraconat on November 20th 2020.