High-precision separation technology: Inroad to a sound material-cycle society

TOKORO Chiharu

Professor, Department of Resources & Environmental Engineering,
Faculty of Science and Engineering

[Short bio]

After graduating from Waseda's School of Science and Engineering and then from The University of Tokyo's Graduate School of Engineering, Professor Tokoro obtained a doctorate in Engineering from the University of Tokyo. She held research associate, full-time lecturer, and associate professor positions at Waseda's School of Science and Engineering (now the Faculty of Science and Engineering) before assuming her current position in 2015. Prof. Tokoro is also a project professor at the Institute of Industrial Science, The University of Tokyo since 2016, and a professor at the Graduate School of Engineering, The University of Tokyo since 2021; she is a member of Section III of the Science Council of Japan, the Engineering Academy of Japan, and a number of councils and study groups at the Ministry of Economy, Trade and Industry and the Ministry of the Environment. Prof. Tokoro was awarded the 2019 Commendation for Science and Technology by MEXT.

- How will your research contribute to carbon neutrality?

My specialty is "separation technology." I am heavily involved in manufacturing at key points in industrial processes, from ore dressing to the extraction of metal materials from ores; from the treatment of wastewater during manufacturing to the recycling of waste materials at the end of their product life. Currently, many material separation systems use high-energy, high-cost, high-environmental-impact technologies. We are contributing to the realization of a sound material-cycle society and carbon neutrality by developing high-precision separation technology that is low energy, low resource input, and low environmental impact. In resource-circulating societies, the input of resources, including energy, is reduced as much as possible, and the value of the input resources is used to the fullest extent. Another important factor is that the people who make up a resource-circulating society must be able to live responsibly without compromising on convenience and without being economically unreasonable. By designing and operating separation technology that makes good use of limited global resources, I hope to support the creation of superior products in the future, contributing to the realization of a society where people can live with a sense of well-being.

- What is the motivation behind this research?

It all started when I heard a speech on TV by a 12-year-old girl at the United Nations Conference on Environment and Development (the 1992 Rio de Janeiro Earth Summit). I was deeply impressed: my until then vague desire to do something useful for society became a clear goal for me: to contribute to the resolution of environmental issues through science and engineering technology. As with mercury and dioxin issues in the past, and plastics problems in recent years, and now the discovery that carbon dioxide emissions have a negative impact on the environment and ecosystems, the world is searching for ways to control those emissions. It is my hope that our society will be able to use resources in a controlled manner by thinking about end-of-life and the collection of materials before releasing products into the world.

- What kind of research are you currently engaged in?

I have been working on chemical separation technology to remove harmful substances from wastewater, and physical separation technology involving the grinding of ores and electronic components, and simulation of those technologies. In recent years, as a derivative of physical separation, I have also developed a new separation technology using electrical power, an innovative electric pulse method, for the separation of rare metals from solar panels and from the lithium-ion batteries used in electric vehicles, both of which are being applied more and more in efforts toward carbon neutrality. In addition, there is a trend toward lightness, not only in airplanes, which have been light for some time, but also in other mobile vehicles, so various parts are being attached with adhesives rather than bolts. I am also working on research to enable clean removal of adhesives as a means of minimizing wastage in the recycling of vehicle parts.

As an academic, I am conscious of the need to go beyond separation technology itself to elucidate the principles behind it. For example, in the electric pulse method, it has been found that in an underlying phenomenon, which takes place in microseconds, the following steps occur: electric current acts as a trigger; expansion takes place due to vaporization and diffusion of the adhesive (agent) by heat conduction; and the impact of the expansion causes exfoliation to occur due to the mechanical and physical force acting on the material to be bonded. Once we understand the principles, we will be able to clearly judge what will happen if we change the conditions. Even within a single separation method, a combination of chemical and physical phenomena take place, and the optimal separation method differs depending on the target of the recycling, so I think of separation as a comprehensive engineering discipline that mobilizes knowledge from chemistry, physics and electricity, at the same time striving to maintain a broad perspective.

- Do you have a message for our readers?

I have been collaborating with material manufacturers and recycling-related companies for a long time, but in recent years, there is increasing collaboration with companies that have unique manufacturing technologies as well. I am happy to see that people are becoming more aware of the need to create products in a manner that has recycling in mind from the start. On the other hand, in order to achieve carbon neutrality, the values of society as a whole need to change away from minimizing cost and creating material satisfaction to a focus on protecting the global environment. I would like to take the campus as a starting point, thinking and taking action together with students and faculty members.