Section of Public Relations	Dongsun Cho Section Chief 062-715-2061	Nayeong Lee Senior Administrator 062-715-2062
Contact Person for this Article	Professor Chang Hyuck Choi School of Materials Science and Engineering 062-715-2317	
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Professor Chang Hyuck Choi's joint research team develops technology to convert substances that cause fine dust into eco-friendly substances

□ GIST (Gwangju Institute of Science and Technology, President Kiseon Kim) School of Materials Science and Engineering Professor Chang Hyuck Choi, KAIST Professor Hyungjun Kim, and Sookmyung Women's University Professor Wooyul Kim's joint research team developed a technology to convert nitrogen monoxide (NO), a majore cause of fine dust, into hydroxylamine *, which is a high value-added compound.

> * hydroxylamine: A substance with the chemical structure of NH2OH, and it is the main raw material for the production of caprolactam, which is a raw material for nylon. It exists as a liquid at room temperature and is considered an effective hydrogen storage material in the green hydrogen society due to its high reactivity with ammonia.

◦ The research team succeeded in producing hydroxylamine, a very selective eco-friendly material, in the actual reaction process by incorporating technology designed based on the utilization and calculation/spectroscopy of iron ion catalysts stabilized at the atomic level.

- Nitrogen, a very abundant element that accounts for 78% of the Earth's atmosphere, circulates around the land, ocean, and atmosphere, and it plays a very important role in the survival of ecosystems, including humans.

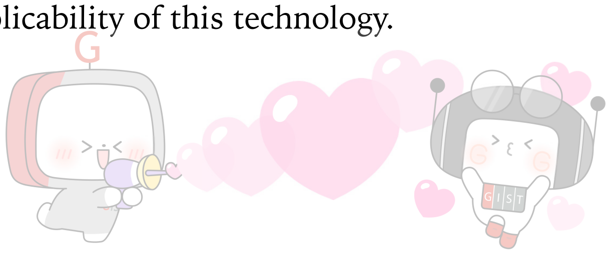
    - However, the increasing demands of livestock, agriculture, transportation, industry and energy sectors produce enormous amounts of nitrogen oxide *, and the resulting severe imbalance in the global nitrogen circulation system causes environmental pollution such as acid rain, soil acidification, and water pollution. In addition, it has been pointed out as a fundamental cause of fine dust, which has recently emerged as a serious social problem.

        * nitrogen oxide: refers to nitrogen monoxide (NO), nitrogen dioxide (NO_2), nitrate (NO_3^-), nitrite (NO_2^-), and nitrous oxide (N_2O). Excessive levels of nitrogen oxides has a tremendous impact on humans and the environment. For example, nitrous oxide has a 300-fold stronger effect on air quality and ozone than carbon dioxide.

- The research team wanted to use electrochemical technology to reduce nitrogen compounds, which are environmental pollutants, while also producing hydroxylamine, a high value-added compound widely used in the textile and chemical industries. To this end, it was noted that nitric oxide is a key intermediate in determining the type of product during the nitrogen oxide conversion process, and an iron monatomic catalyst was introduced to control the path of the reaction.

    - The research team confirmed that oxidized monoatomic iron ions promote the reduction of nitrogen monoxide through various basic experiments using spectroscopy. Furthermore, it succeeded in controlling the production of hydroxylamine by controlling the acidity of the electrolyte. Using a computational chemical approach and infrared spectroscopic analysis, the analysis of reaction mechanism revealed that the reaction path varies with the strength of the electric field around the nitric oxide adsorbed by monatomic iron ions.

- Based on these findings, the researchers succeeded in producing stable hydroxylamine from nitrogen monoxide without additional external energy supply and confirmed the practical applicability of this technology.



- GIST School of Materials Science and Engineering Professor Chang Hyuck Choi said, "The result of this research makes it possible to reduce nitrogen oxide, an important cause of fine dust, and secure raw materials for fiber production, as well as to utilizing it for green hydrogen storage, killing three birds with one stone. In the future, it is expected that it will be possible to establish an eco-friendly system to convert environmental pollutants such as exhaust gases into useful substances for our lives.

- This was was conducted by the joint research team of GIST Professor Chang Hyuck Choi, KAIST Professor Hyungjun Kim, and Sookmyung Women's University Professor Wooyul Kim with support from the National Research Foundation of Korea and the KIST Institutional Program and was published online on March 25, 2021 in *Nature Communications*, a world-renowned academic journal.

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