Development of Photo-Switching Ocean-Degradable Plastics with Edibility

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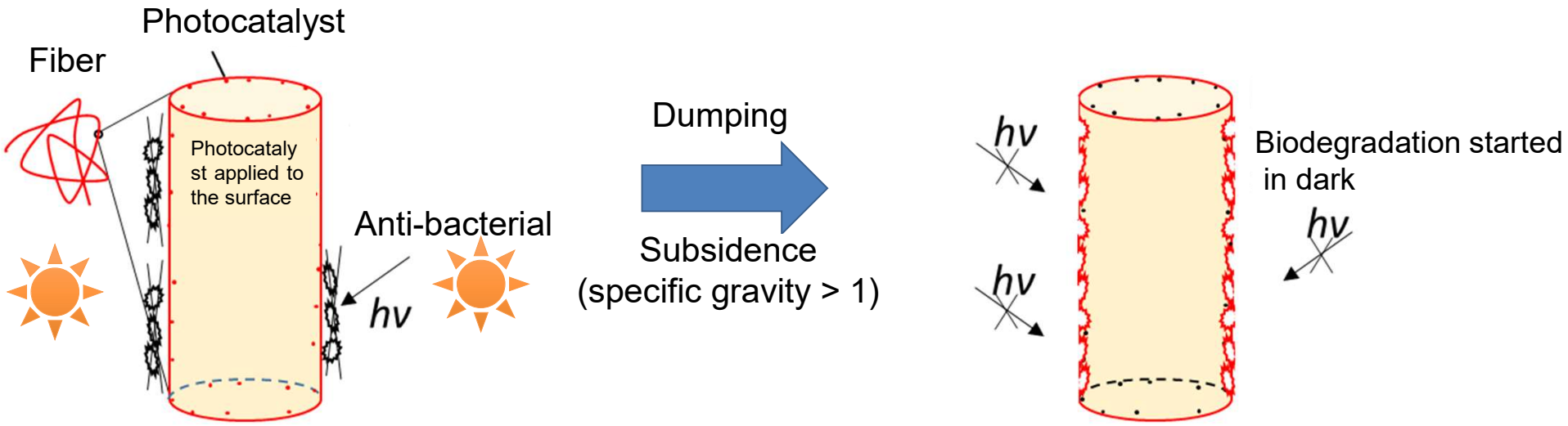
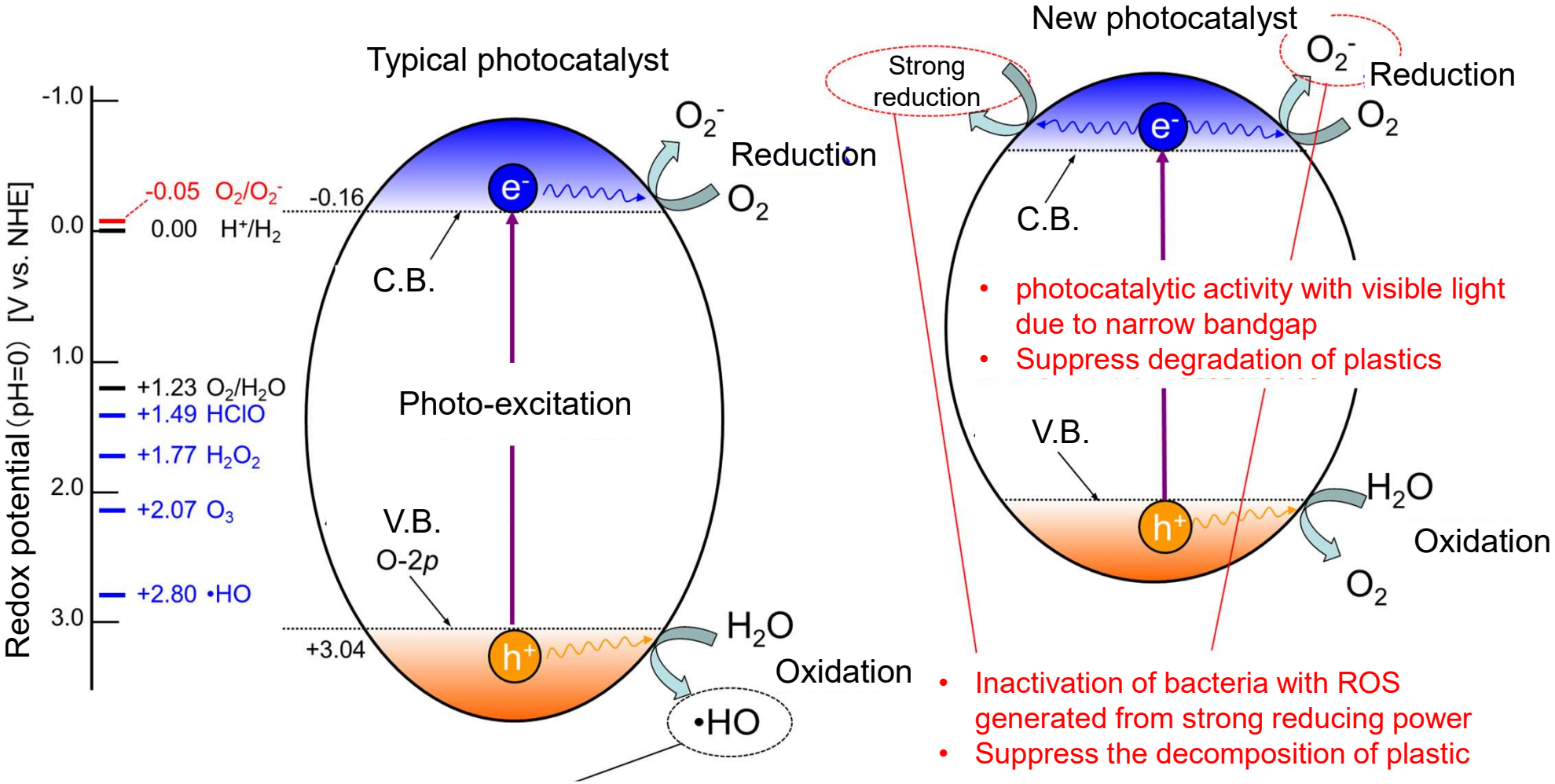
Tokyo University of Agriculture and Technology,
National Institute of Advanced Industrial Science and Technology(AIST),
Osaka Research Institute of Industrial Science and Technology(ORIST).

Bio-degradable plastics with OFF-type photo switch system 2



Development of antibacterial photocatalyst

Photocatalyst that can be sterilized under visible light without decomposing polymer



- photocatalytic activity with visible light due to narrow bandgap
- Suppress degradation of plastics

- Inactivation of bacteria with ROS generated from strong reducing power
- Suppress the decomposition of plastic

Most organic substances including polymer and bacteria can decomposed by the strong oxidizing power of reactive oxygen species.

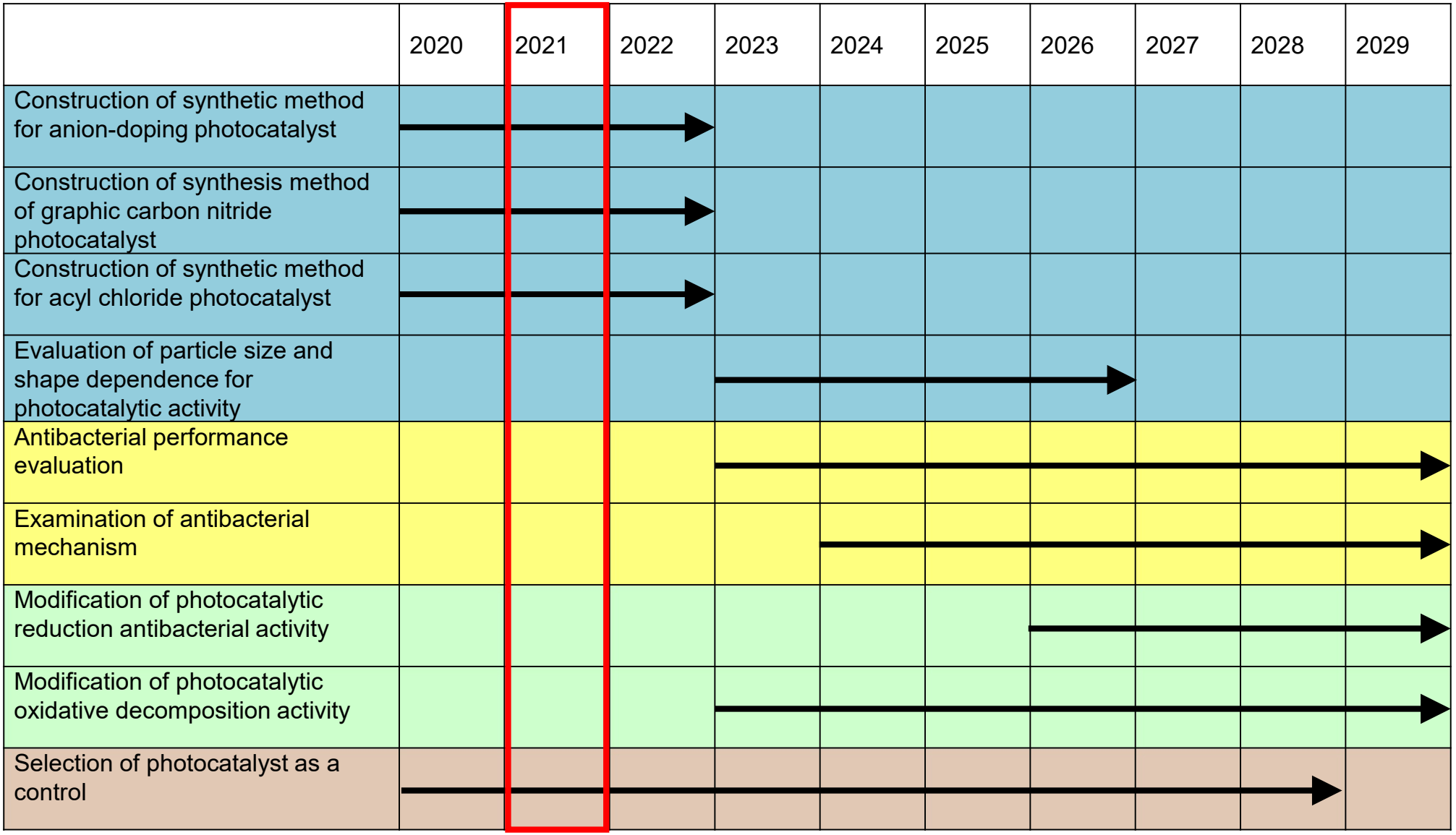
Final goal in FY 2029

FY 2029 Goal [Final Goal]:

Comprehensively considering the results and findings obtained so far, it shows antibacterial properties by a photocatalyst that prevents biodegrading bacteria from growing on the polymer surface during use, and antibacterial activity in dark places such as underwater, seabed, and compost after use. The ultimate goal is to develop an OFF-type photo switch system in which biodegradation progresses and its mechanism is clarified (in charge: Tokyo University of Agriculture and Technology, Tokyo University of Science, JAIST, National Institute of Advanced Industrial Science and Technology).

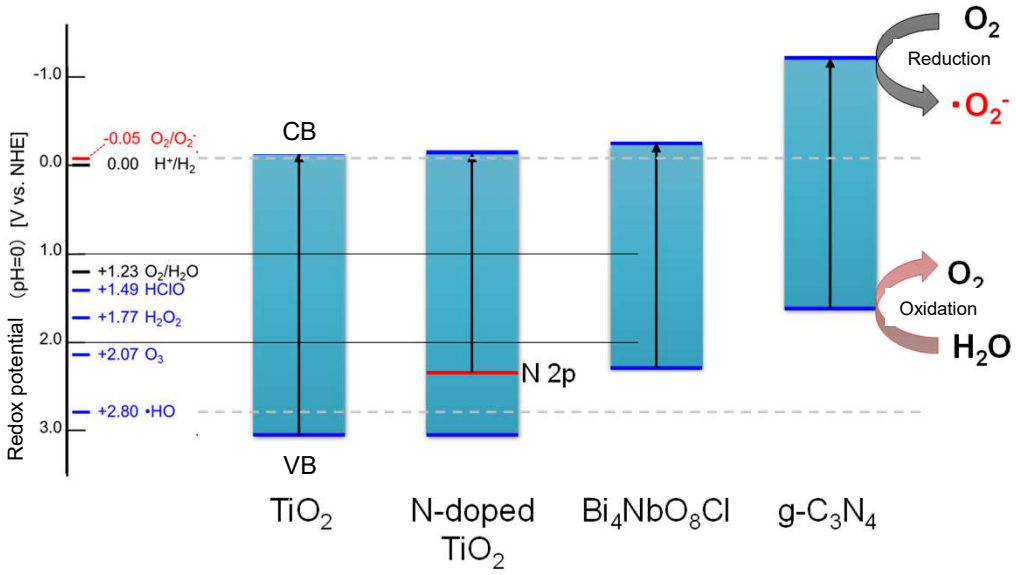
Plan and contents

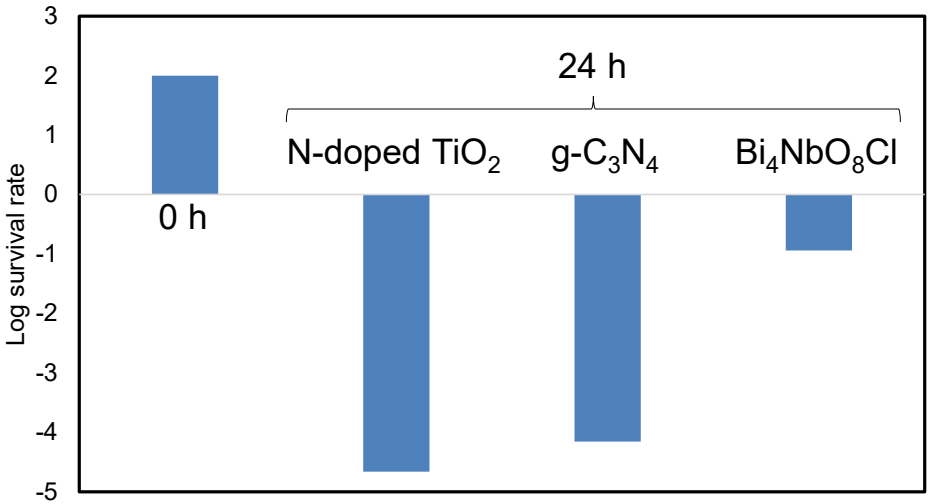
Development of photocatalyst with antibacterial function



Achievements in FY 2020

Search for a photocatalyst that exhibits antibacterial properties with visible light and does not damage the polymer

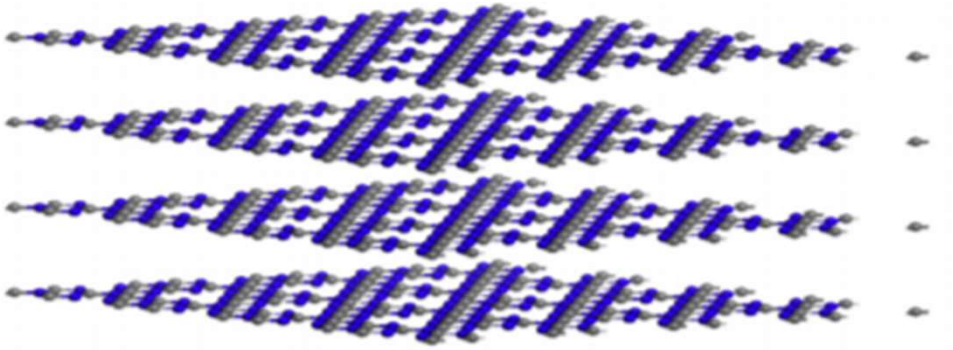




Syntheses of visible light responsive photocatalysts and confirmed that it exhibits antibacterial properties

$g\text{-}C_3N_4$

Of the three types of visible light responsive photocatalysts, we focused on the $g\text{-}C_3N_4$ photocatalyst, which has high antibacterial activity and low toxicity, and examined its improvement.



Two-dimensional structure of $g\text{-}C_3N_4$

Layered structure allows high recombination rate and small specific surface area, which suppress high photocatalytic activity.

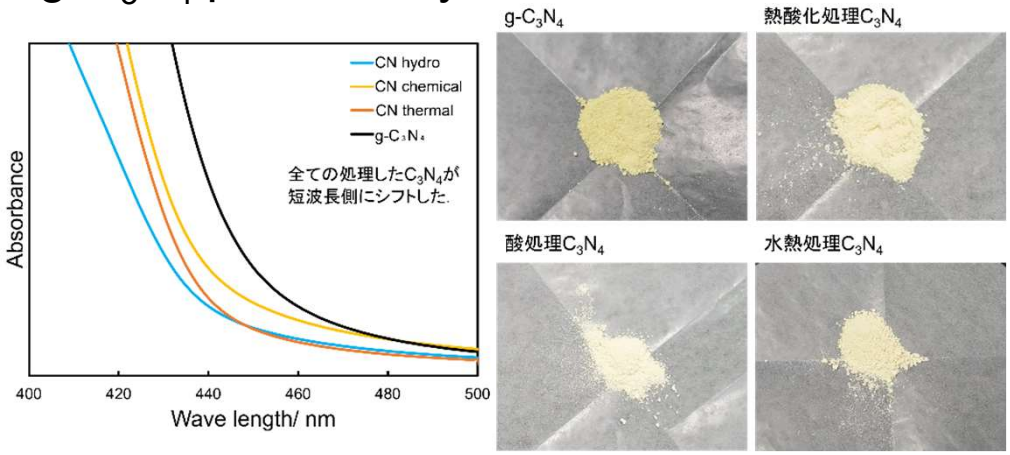
Peel off the layered $g\text{-}C_3N_4$

- Thermal oxidation（CN thermal）
- Hydro-thermal oxidation（CN hydro）
- Acidic treatment（CN chemical）

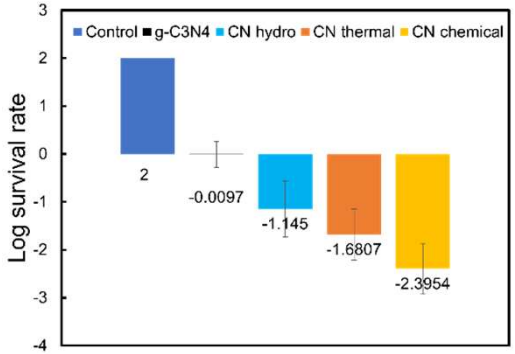
- Recombination suppression + high specific surface area
- Uncolored
- High dispersibility in solvent

Achievements of this year

Various treatments were performed on the g-C_3N_4 photocatalyst.

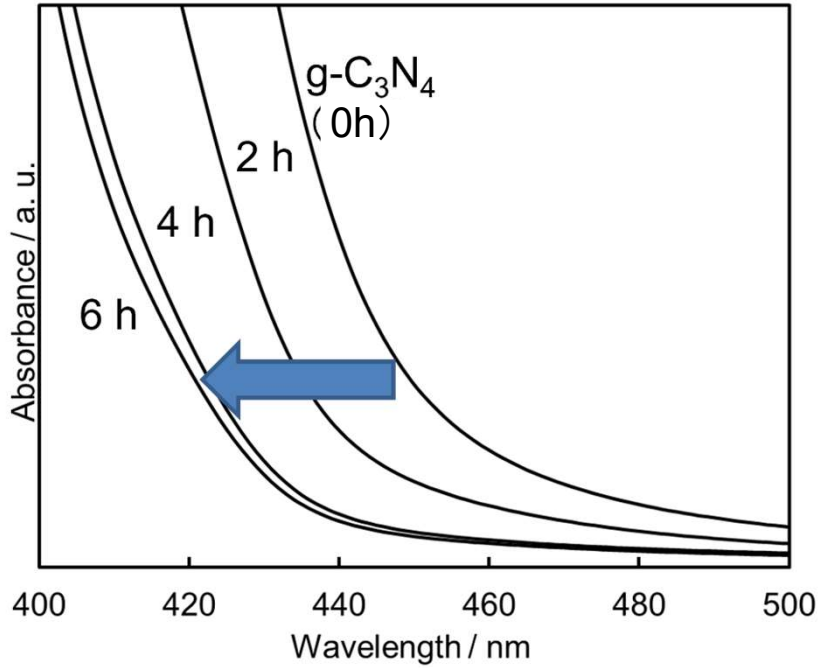


- All of g-C_3N_4 were blue-shifted by thermal oxidation treatment, acid treatment, and hydrothermal treatment.



- Antibacterial activity was improved by thermal oxidation treatment, acid treatment, and hydrothermal treatment of g-C_3N_4.

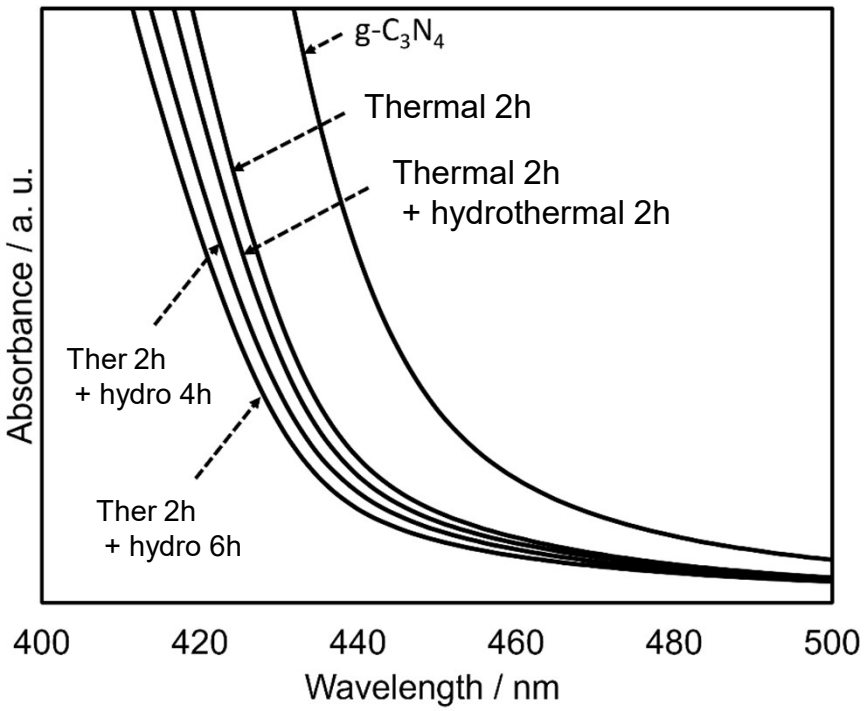
We investigated the optimization of the thermal oxidation treatment time of the g-C_3N_4 photocatalyst.



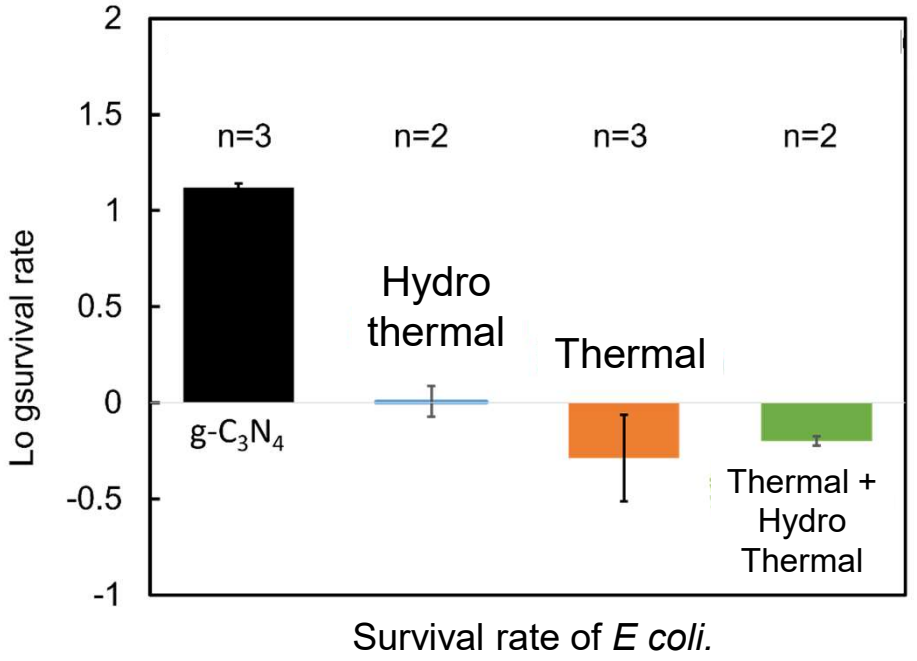
- As the thermal oxidation treatment time became longer, the absorption edge was blue-shifted.
- Since the sample having a long thermal oxidation treatment time is lighter in color than the sample having a short thermal oxidation treatment time, it is expected that it will be easier to apply to white fibers in the future.

Achievements of this year

The thermal oxidation treatment of the g-C_3N_4 photocatalyst has antibacterial activity, but it is considered that there are few hydrophilic groups on the surface of g-C_3N_4, thus there is a possibility that the wettability when coating fibers etc. in the future is poor. Therefore, we considered further hydrothermal treatment of the thermal oxidation-treated g-C_3N_4 photocatalyst.



- When the thermal oxidation-treated g-C_3N_4 photocatalyst was subjected to hydrothermal treatment, the absorption edge gradually blue-shifted as the treatment time increased.



Survival rate of *E coli.*

- The sample obtained by hydrothermally treated the g-C_3N_4 photocatalyst subjected to the thermal oxidation treatment showed the same antibacterial activity as the case of the thermal oxidation treatment.
- In the future, we plan to study the dispersibility of the sample.

Plan and achievements in FY 2021

- Continuing from last year, we investigated the synthetic process of anion-doped photocatalysts, graphitic carbon nitride photocatalysts, and silene-aulibyrias-based acidified photocatalysts that function in the ultraviolet to visible wavelength range. And, we will clarify the relationship between the elemental species dependence of anion doping, the synthesis condition dependence of graphitic carbon nitride photocatalysts and silene-aulibilias-based acidified photocatalysts, and photocatalytic activity. (Responsible: Tokyo University of Agriculture and Technology, Tokyo University of Science)

Achievement：95%

→Regarding the antibacterial test, we had a meeting with Dr. Nakayama of AIST and Dr. Masui of Osaka AIST to confirm the details of the test conditions (October 21).
→ Joint research with Prof. Ogino of Kobe University on cytotoxicity of g-C_3N_4 photocatalyst (sample has been sent)

- Continuing from last year, we will continue to investigate evaluation methods for photodegradation and biodegradation of polymers.
- (Responsible: Tokyo University of Agriculture and Technology, Tokyo University of Science, Japan Advanced Institute of Science and Technology, National Institute of Advanced Industrial Science and Technology)

Achievement：95%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