Misganaw Alemu Zeleke, ***PHOTODEC [Design and Synthesis of $M_x(O,S)_y$ Heterostructures and Nanocomposites for PHOTOcatalytic DEgradation of Contaminants of Emerging Concern and Industrial Waste Chemicals]***

Numerous waste products are continuously discharged to our environment in solid, liquid, and gaseous forms. Human beings are the main responsible actors for the depletion of every part of the ecosystem either directly or indirectly. The presence of unregulated and unmonitored contaminants, called Contaminants of Emerging Concern (CECs), at low concentrations (µg/L and sub-µg/L) in surface, ground, and drinking water is becoming an increasing concern for the scientific communities and the public in general. They include different varieties of pharmaceuticals, personal care products (PCPs), debris of microplastics (MPs), flame retardants (FRs), pesticides, and artificial sweeteners (ASWs). These products are continuously released in the environment from pharmaceutical manufacturing plants, health care institutions, personal care product manufacturers, veterinary offices, pharmaceutical research centers, hospitals, pharmacies, distribution centers, and households. They pass through different routes, are incorporated into different water systems, and develop other, chronic, secondary contaminants including the killer Antibiotic Resistant Bacteria (ARB).

Antimicrobial resistance is developed when germs including bacteria and fungi develop the ability to defeat the drugs designed to kill them and continue to grow and reproduce. Antibiotic Resistant Bacteria develop the ability to defeat the drugs designed to kill them and continue to grow and reproduce. Although some bacterial population exposed to antibiotics in the environmental system can be killed, some of it mutates and multiplies to the highest level of maxima, and their antibiotic resistant nature becomes genetical and transferable to the nearby bacteria. This is to mean that a person affected by ARB cannot be cured any more by using the commercially available antibiotic drugs. According to the 21st of November 2023 report of WHO, it is estimated that ARB were directly responsible for the death of 1.27 million people globally in 2019. It is also expected that the deaths caused by ARB will increase to 10 million people by 2050 if alternative solutions are not designed. Therefore, researchers must work collaboratively to prevent the impacts of these harmful emerging chemical pollutants.

This DOROTHY research project will focus on the synthesis of emerging nanomaterials for degradation of chemical pollutants into non-toxic forms. The photodegradation approach is one of the alternative ways to tackle the impact of ARB on public health. The main objective of the project is to design and synthesize transition metal oxy-sulfide $[\mathrm{M_x(O,S)_y}]$ heterostructures and nanocomposites and develop glass supported photocatalyst devices. This will include (1) design and synthesis of doped, nanocomposite, or both doped and nanocomposite forms of $[\mathrm{M_x(O,S)_y}]$ nanomaterials, (2) selection of best efficient powder catalyst compositions through

photodegradation of model organic pollutants including Methylene Blue and Methyl Orang followed by antibiotics including Ciprofloxacin and sulfamethoxazole, and (3) loading the best powder nanocatalyst compositions over the surface of suitable glass substrates (GS) to form thin film photocatalyst devices $[\mathrm{M_x(O,S)_y@GS}]$. The photodegradation performances of the developed devices will also be checked towards degradation of antibiotics from potential waste treatment plants. The long-term aim of the project is to develop a device that could be scaled-up for large-scale application at the industry and large wastewater treatment plant level and minimize or diminish the impacts of antibiotics on human health globally.

As part of the DOROTHY fellowship activities, the fellow presented his project to his supervisors, mentor, lab-mates, and friends of related research fields and others both directly and indirectly. Misganaw is currently working on building an equipped laboratory comprising necessary chemicals and equipment for Photodegradation Applications. He has already started to synthesize $Ni_x(O,S)_y$, $(Ce,Ni)_x(O,S)_y$, CeO_2, $Ce_x(O,S)_y$, $CeO_2@Ni_x(O,S)_y$, and $Y_x(O,S)_y$ photocatalyst nanomaterials at different conditions and designs. The fellow is also conducting preliminary photodegradation experiments using model organic pollutants. In the meantime, he has attended online and in-person training opportunities relevant for his future endeavors, including Bibliometrics for your CV, Open Access Publishing, and Researcher Career Development Workshop. Misganaw also aims to arrange outreach activities for the youngsters, alongside discussions and knowledge sharing activities with voluntary groups working on the environment and online training on the impact of chemical pollutants to human health.

Further information about the project can be found on the project's Blog Page.