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Project 1: Catalytic Elemental Mercury Oxidation

The U.S. EPA's new final rule, Mercury and Air Toxics Standards, requires coal- and oil-fired power plants to use maximum available control technology to strictly regulate the emissions of mercury and other hazardous air pollutants by more than 90% effective in 2016. Among elemental, oxidized, and particulate-bound mercury species present in flue gas, elemental mercury vapor is most difficult to control because of its low concentrations, low reactivity, and low solubility in water. Elemental mercury vapor has a long residence time in the atmosphere, and thus contributes to global-scale deposition. Dr. Lee's research group is studying detailed reaction mechanisms and kinetics responsible for the catalytic oxidation of a catalyst that his lab has developed. He is also investigating the reaction and adsorption characteristics of elemental mercury vapor for a chemical adsorbent. A Protégé student will work with his graduate student on mechanistic and kinetic studies of elemental mercury over the catalyst.

Project 2: Targeted and Controlled Gene and Drug Delivery for Cancer Therapeutics

The development of nano-scaled carriers as a drug delivery platform has made a tremendous difference in the fight against cancer. Significant progresses have been made in improving linker stability, biocompatibility, and biodegradability of a delivery system, targeting, and drug potency. Among many challenges, metastasis and multi-drug resistance phenomena still remain major challenges that limit the technological development of effective nanotechnology-based drug delivery systems. To address these technical challenges, Dr. Lee's lab is developing a new class of smart drug delivery system for simultaneous gene and drug delivery to target tumor and metastatic cancer cells. This novel nanoparticle-based delivery system has a few notable features of targeting to specific cells and sequential release of gene and drug for maximum efficacy. This new nanoparticle design is expected to be able to significantly reduce toxic side effects of conventional drugs used in chemotherapy with significantly less amount of conventional drugs.