Synopsis of Research projects and interests in Dr. Zerihun Assefa’s group.

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General area of Research: Synthesis and X-ray crystallography of Inorganic complexes and Spectroscopic studies. Solid state materials for white light emission, Luminescent sensor development for VOC detection, Excited state energy transfer applications,

1) Development of Luminescent Sensors for VOC’s: The development of rugged, chemical sensor materials has received increasing attention with the growing need to detect volatile organic compounds (VOCs) in the environment and the workplace. Of particular interest has been on the development of "vapoluminescent" compounds that can incorporate VOCs of interest and change their luminescent behavior. The synthesis of designer ligands capable of accepting targeted VOCs of interest are being conducted in the group. In a related area the importance of metal containing polymers as an alternative approach for sensor application is also growing. Au(I) and Pt(II) based compounds are of particular importance due to their unique physical and chemical properties in VOC sensor applications. A class of materials targeted in this proposal are Pt(II) based coordination polymers that exhibit "vapoluminescent" properties. These materials have unique features in that their square planar units stack one unit on top of the other forming a one dimensional columnar arrangement with nominal metal-metal interaction. In several instances the materials exhibit a hollow low-dimensional structure allowing VOC molecules to line channels along a particular crystallographic axis and provide a possible route for diffusion of vapors in and out of the host lattice. Development of fiber-optical system can be formulated by attaching the lanthanide-platinum tetracyano complexes to the surface of a fiber-optical luminescence sensor to allow the reflected light path across the thickness of the tetracyano layers. The lanthanide-platinum tetracyano complexes will be grounded into micro- nano- scale particles and mixed with the polymerization/crosslinking reaction suspension and to form in situ nanocomposite polymer film on the fibre-optic luminescence sensor. Such approach requires the concerted effort of scientists from multidisciplinary background

2) Tailoring Late transition metal complexes and Multidentate ligands for Simultaneous Sensitization of Lanthanide Emissions.

The usual impediment in lanthanide ion spectroscopy is that direct absorption of the f-f excited states is very inefficient. Although great progress has been made in circumventing this problem through lanthanide sensitization, the conversion efficiency of the absorbed photon to visible emission is typically still low. Of the several causes for low efficiency the main ones are: 1) mis-matches in donor-acceptor energy levels and donor-acceptor lifetimes and; 2) the presence of non-radiative quenching process of the sensitized emission. Research in this area will address some of these hindrances through a rarely used approach of rationally chosen multiple donors to sensitize the emission from lanthanide systems. The strategy of using more than one donor to simultaneously sensitize lanthanide emission has attracted very little attention thus far. Only a handful of studies investigated the effects of dual-donor systems. Even in those
few examples the studies appear accidental and no significant recognition of the cooperative effect in enhancing emission quantum yield has been reported. As a result, no coherent approach for cooperative sensitization exists.

iii) Developing and fundamental understanding of white light-emitting novel materials: The development of inorganic phosphors has stimulated a growing interest for applications in field emission displays, automobile headlight, radiation detectors, and white light-emitting diodes (WLEDs). Solid-state lighting (SSL) is one of the most promising areas for energy saving as WLEDs are considered to be the next generation lighting technology used for general illumination. There are two general approaches to the generation of white light: (1) mixing three monochromatic sources (red, green, and blue), or (2) using phosphors to convert UV or blue light into a combination of red, green, and blue; or yellow and blue. From the inorganic hosts, , crystalline Ca(W,Mo)O$_4$ systems have been considered to be superior hosts for Ln$^{3+}$ ions due to their chemical and thermal stability. In addition to their intrinsic luminescent properties, their capacity to efficiently transfer their excitation energy to emitting Ln$^{3+}$ centers is a predominant motivation to study these systems. A research project in this area can proceed through production of thin films of these materials using two different approaches. The first approach may involve dip coating of the “sol”, prepared by the Pechini technique, at very slow rate onto substrate surface and annealing and reduction for shorter time. A second approach can be the use of pulsed laser ablation method. Once thin films are successfully attained photoluminescence (PL) and cathodoluminescence (CL) emission studies will be conducted in order to understand the quantum-size effect on the band-structure of the tungstate and molybdate systems.