Notice of the Final Oral Examination
for the Degree of Doctor of Philosophy

of

MEAGAN BEATTY

BSc (University of the Fraser Valley, 2014)

“Assemblies and Supramolecular Sensors that Operate in Competitive Aqueous Solutions and Biofluids”

Department of Chemistry

Friday, September 6, 2019
9:00 A.M.
Elliott Building
Room 230

Supervisory Committee:
Dr. Fraser Hof, Department of Chemistry, University of Victoria (Supervisor)
Dr. Cornelia Bohne, Department of Chemistry, UVic (Member)
Dr. Jay Cullen, School of Earth and Ocean Sciences, UVic (Outside Member)

External Examiner:
Dr. Richard Hooley, Department of Chemistry, University of California, Riverside

Chair of Oral Examination:
Dr. Andrew Schloss, School of Music, UVic

Dr. David Capson, Dean, Faculty of Graduate Studies
Abstract

Nature has inspired chemists to develop complex assemblies that perform functions in biologically relevant solutions. Yet this is not a trivial task. Not only does water act as a competitive medium but the salts that are inevitably present hamper supramolecular hosts from properly binding and carrying out their programmed function.

This work was inspired by a serendipitous discovery of water-soluble functionalized calix[4]arenes that self-assemble into homodimers in salty water, mock serum and real urine. This thesis aims to explore this homodimerizing motif to learn more about self-assembly in salty water and to develop useful supramolecular tools. First the structural limits of the calixarene motif was explored by the transformation into a clip-like host that assembled similarly in water. NMR titrations revealed that the homodimers responded to hydrophobic cationic guests by dissociating to form new host-guest complexes.

The resilience of the self-assembling motif was then tested against extreme co-solute conditions. In this part of the study, reversible covalent bonds were introduced within the dimer scaffold to afford a dynamic library of exchangeable hosts. Quantitative NMR was used to monitor each host in response to molar concentrations of urea and salt.

This work also reports on a new class of salt-tolerant supramolecular chemosensors, called DimerDyes. These sensors form quenched homodimers in water but dissociate in the presence of hydrophobic cations to form new emissive complexes. Its mode of action was characterized by DOSY, 1H NMR and fluorescence spectroscopy. DimerDyes successfully monitored enzymatic reaction in real-time despite the presence of competitive salts and co-factors. The DimerDye concept was quickly expanded by the parallel synthesis of crude DimerDyes and efficient testing for illicit drugs without the need for purification. “Hit” dimers were then purified, characterized and were able to detect multiple different drug classes in real saliva.