Direct detection of aqueous Hg(II) by DGT-supported biosensor

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Mercury (Hg) contamination of natural waters remains a severe threat to the drinking water safety of many, often economically challenged, communities and can pose a huge stress to aquatic ecosystem health [1]. A major, long-standing challenge for detecting and managing aqueous Hg contamination is the development of reliable monitoring technologies that are sensitive, field-deployable and user-friendly, as opposed to time-consuming and laborious laboratory-based instrumental analysis [2]. Additionally, new monitoring technologies should be durable and potential environmental interferences should be recognized and addressed.

To meet this challenge, we developed a new sensing method for aqueous Hg(II) by integrating a novel DNA-based biosensing material [3] with the diffusive gradients in thin films (DGT) technique [4]. In this new hybrid DGT-biosensor the DNA-functionalized polyacrylamide hydrogel acts as the Hg(II) binding layer. Test results indicate high selectivity and binding capacity (~50 μmol Hg disk^{-1}) toward Hg(II) in aqueous solutions of variable complexity containing inorganic ligands (e.g., Cl^-, OH^-) and dissolved organic matter (DOM, e.g., fulvic acids). Performance tests show that variations in pH, temperature and concentrations of Cl^- and DOM play dual roles by (1) regulating the effective diffusion coefficients of Hg(II) species through the DGT unit and (2) impacting Hg^{2+} binding to the DNA in the DGT binding layer. These environmental interferences, however, can be accounted for by reactive transport modeling using temperature and diffusion coefficient calibrations. After the model corrections, the hybrid DGT-biosensor is shown to yield accurate quantification of Hg(II) concentrations across a wide range of hydrochemically distinct freshwaters.

[1] Calder *et al.* (2016) *ES&T* **50**, 13115-13122. [2] Kruse (2018) *J PHYS D* **51**, 203002. [3] Pi *et al.* (2020) *JHM* **385**, 121572. [4] Davison & Zhang (2012) *ENVIR CHEM* **9**, 1-13.