Invited Lecture
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Molecular Self-Assembled Chemosensor Arrays

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Abstract:

Much effort has been devoted to chemosensors because of their high classification accurary in array systems. However, their complicated syntheses might prevent their industrialization. To overcome this problem, we focus on molecular self-assembled chemosensor arrays using catechol dyes to obtain smart functionality without syntheses.[1−3]

1) Glyphosate Sensing[2]

Glyphosate (GlyP) is well known as a herbicide and is considered toxic to human and environment. Thus, the GlyP detection is crucial to avoid health hazard and environmental concern. We fabricated a colorimetric chemosensor array using ARS, BPR, PR, PV and a Zn^{2+} ion (Figure 1a). The detection mechanism is a competitive coordination binding of Zn^{2+} between catechol dyes and targets. The chemosensor array made of catechol-Zn^{2+} complexes responded to oxyanions including GlyP, resulting in 100 % correct classification in linear discrimination assay (LDA) (Figure 1b). The subsequent quantitative analysis for GlyP in tap water also provided excellent prediction quality.

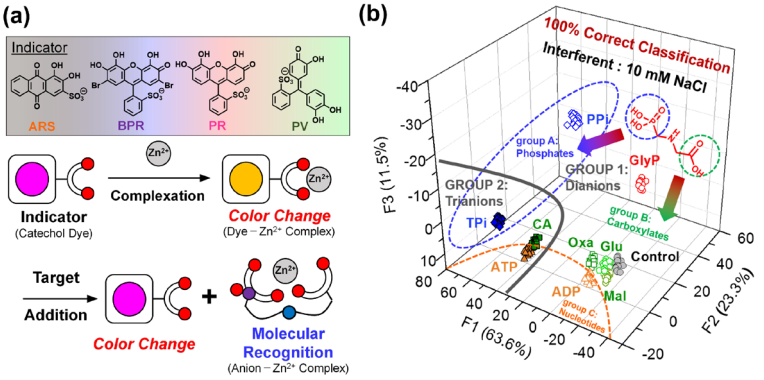

Figure 1. (a) Chemical structure of catechol dyes and sensing mechanism of GlyP. (b) Linear discrimination analysis (LDA) for various oxyanions including GlyP. PPi: pyrophosphate, TPi: triphosphate, ATP: adenosine-5'-triphosphate, ADP: adenosine-5'-diphosphate, CA: citrate, Oxa: oxalate, Mal: malonate, Glu: glutamate.

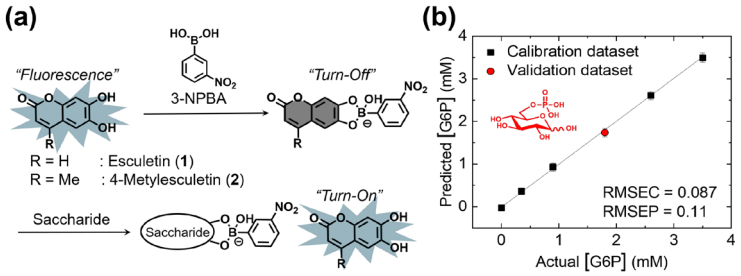

Figure 2. (a) Sensing mechanism of saccharides. (b) Quantitative analysis for G6P by SVM regression. The values of the root-mean-square error of calibration (RMSEC) and prediction (RMSEP) prove high accuracy of the model and its predictive capacity.

2) Phosphosaccharide Sensing[3]

Phosphosaccharides such as glucose-6-phosphate (G6P) play important roles in glycolysis pathway, while easy-to-visualize methods for the level of phosphosaccharides are still rare. In this regard, we fabricated an indicator-displacement-assay based chemosensor array using two catechol fluorophores and 3-nitrophenyboronic acid (3-NPBA) (Figure 2a). The array system could recognized fourteen types of monosaccharides with 100% correct classification. Quantitative analysis with a support vector machine (SVM) resulted in successful prediction of the respective concentrations of phoshosaccharides in mixtures (Figure 2b). Notably, the chemosensor array system was found to be applicable under physiological conditions.

References:

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Bio-Sketch of the Speaker

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Tsuyoshi Minami was born in Saitama, Japan, in 1983. He received his BEng (2006) and MEng (2008) from Saitama University, he then obtained his PhD from Tokyo Metropolitan University, under the direction of Prof. Yuji Kubo, in 2011. During his PhD studies he worked with Prof. Tony D. James of University of Bath (UK) on collaborative projects. Between 2011 and 2013 he was a Postdoctoral Research Associate at Bowling Green State University (US) working with Prof. Pavel Anzenbacher, Jr. In 2013 he was appointed as Research Assistant Professor at the same University. Then he moved to Yamagata University (Japan) as an Assistant Professor in 2014. He was appointed as a Lecturer at The University of Tokyo in 2016, and then he has been an Associate Professor since 2019 at the same University. His current research interest is “applied” supramolecular chemistry. Especially, supramolecular sensors for biologically important species or pollutants are some of the most promising applications of molecular recognition materials. To be harnessed for rigorous analytical assignments, his research centers on molecular design and synthesis of materials for organic thin-film transistor-based chemical sensors and high-throughput analysis based on supramolecular sensor arrays.