



# Polymer/Metal-Based Sensors for Tamper-Indicating Enclosures

Jason Livesay, Matthew Humphries, and Cody Corbin

Sandia National Laboratories, 1515 Eubank Blvd. SE, Albuquerque,

## Introduction

Tamper-indicating enclosures (TIEs) reveal visually obvious irreversible changes to identify access to an item of interest. Transition metal complexes can be vibrantly colored. This color is dependent on the ligand's structure (organic molecule's structure) and it's interacts with the metal complex. This interaction can be applied to TIEs in that the transition metal salts can be isolated from the organic molecule initially and once damage is inflicted the metals are released allowing the interaction with the organic molecule to occur.

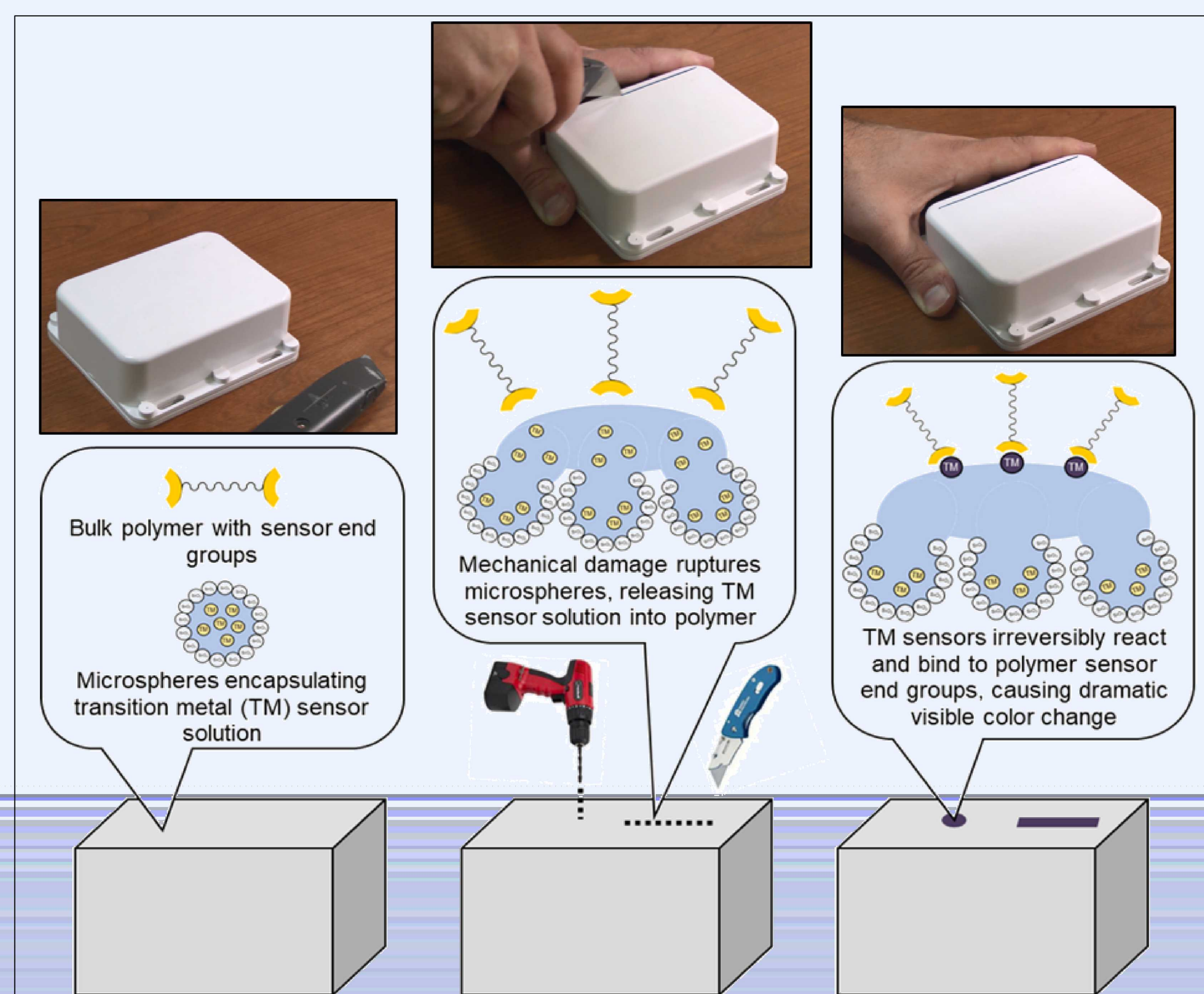


Figure 1: General representation of concept.<sup>1</sup>

## Methodology

- Synthesized sensor molecule and verified with <sup>1</sup>H NMR spectroscopy
- Evaluated various transition metal salts with sensor
- Cured sensor in polymer matrix and observed color change when a drop of aqueous metal salt solution was added to surface of polymer.

## Results

NM 87123

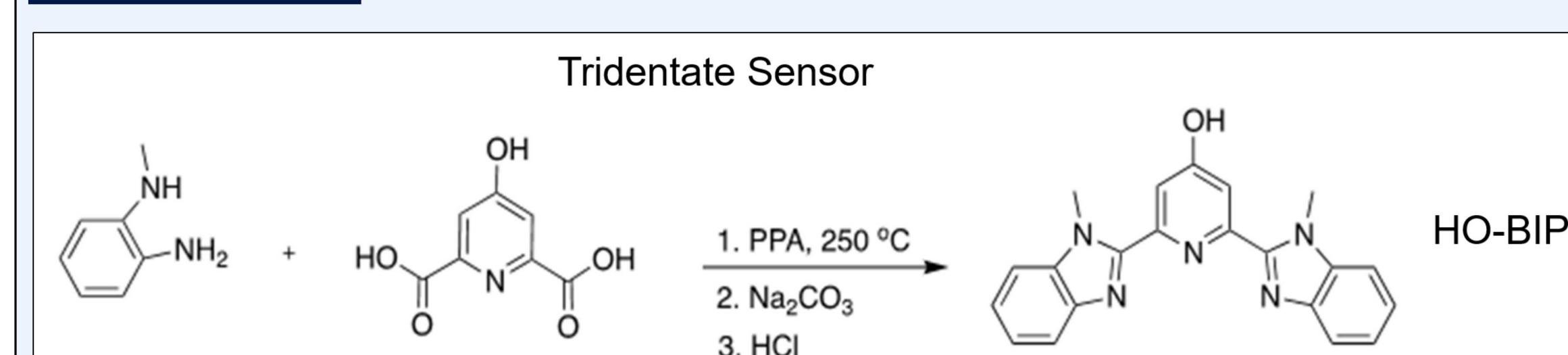


Figure 2: Synthesis of HO-BIP (2,6-bis(10-methyl-benzimidazolyl)-4-hydroxypyridine).<sup>2</sup>

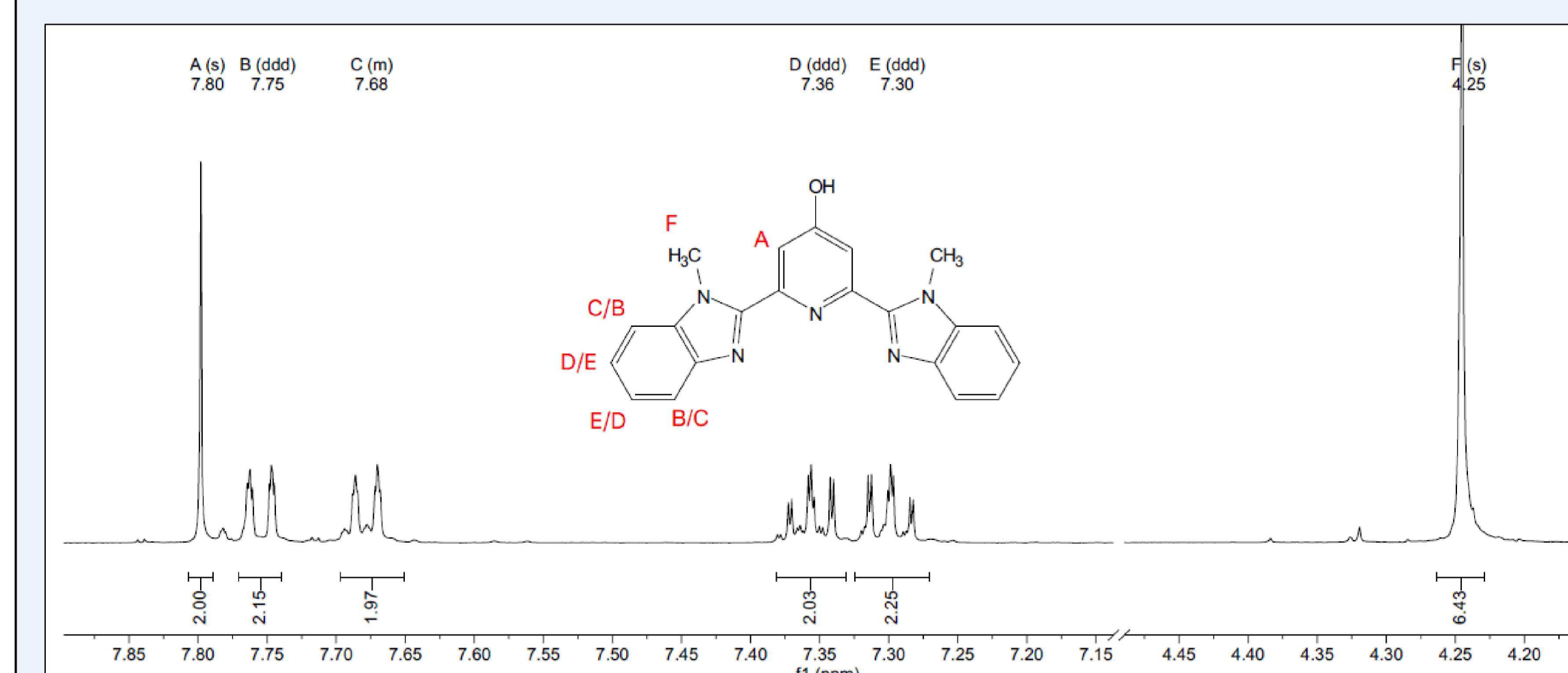


Figure 3: <sup>1</sup>H NMR spectrum of synthesized HO-BIP.

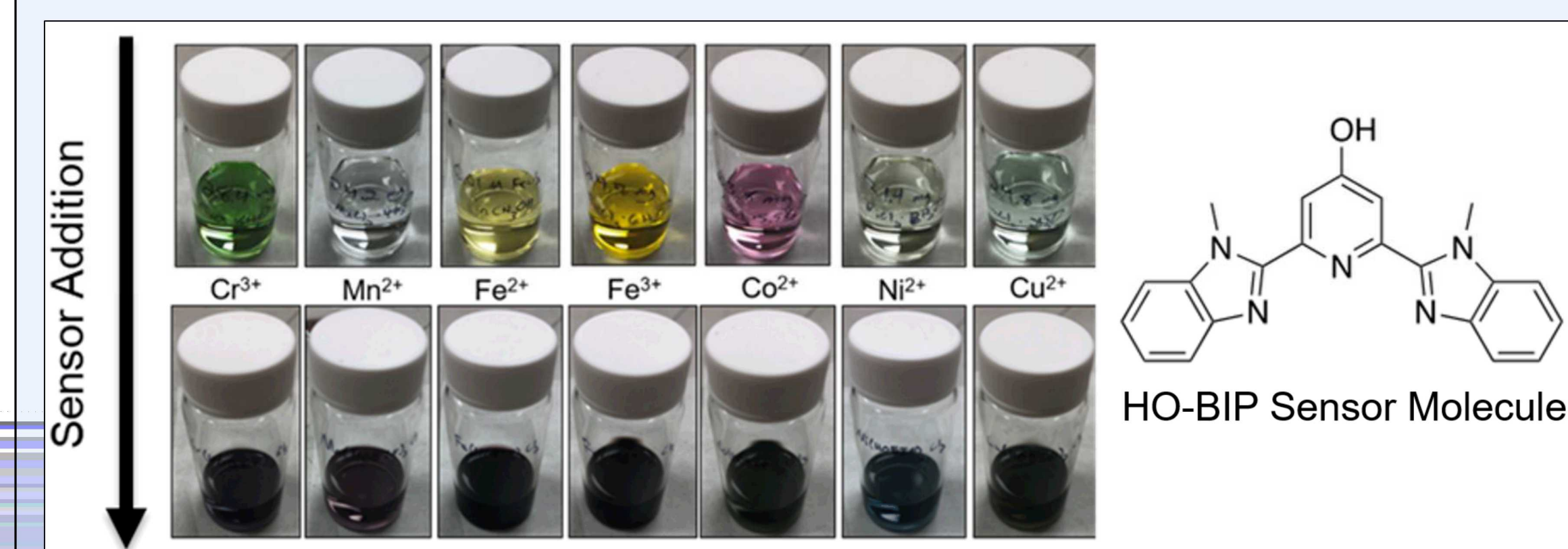


Figure 4: Evaluation experiment of color change with the addition of sensor to transition metal solution.

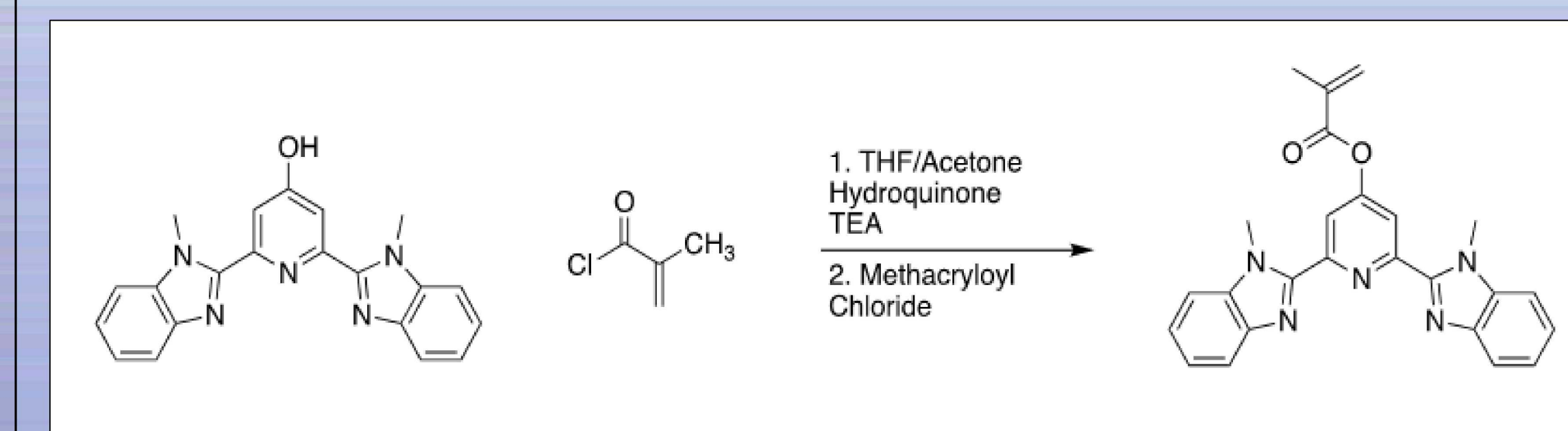


Figure 5: Synthesis of MA-BIP (2,6-bis(10-methyl-benzimidazolyl)-4-pyridinylmethacrylate).<sup>3</sup>

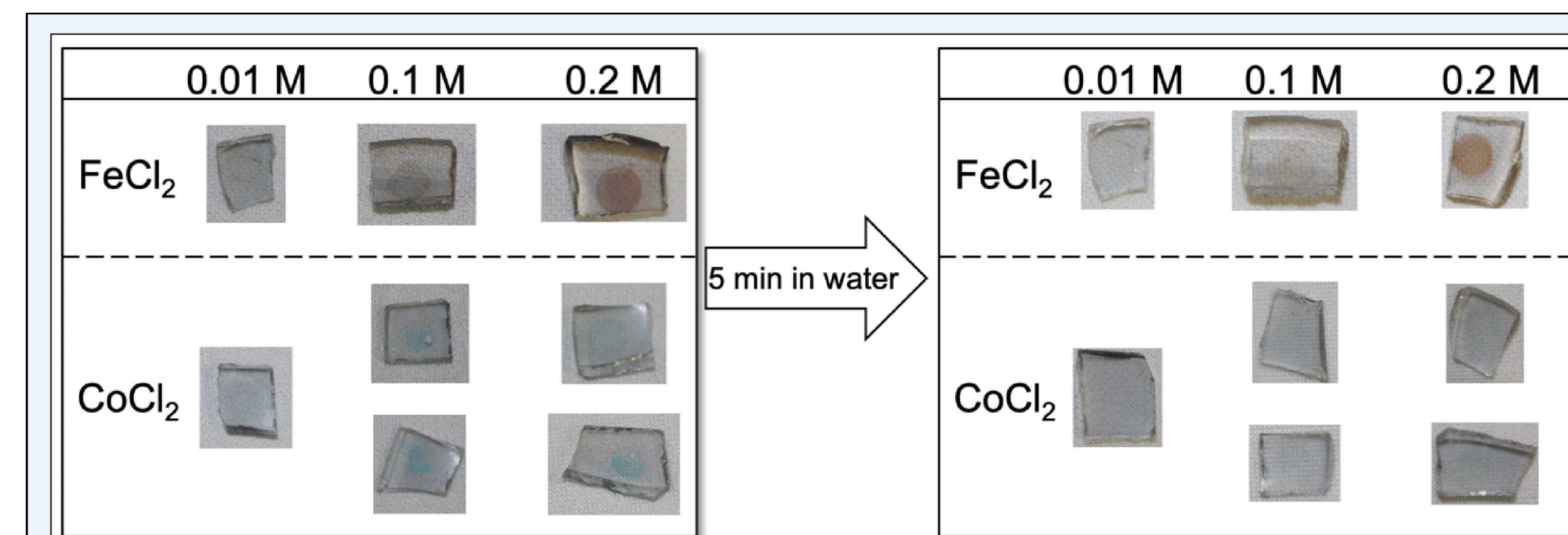


Figure 6: Transition metal solution added dropwise to sensor containing PEGDA polymer.

- Polymer samples were additionally soaked in HCl for 5 minutes.
- Significantly less fading was observed for the FeCl<sub>2</sub> samples after soaks.

## Conclusion

- The sensors HO-BIP and MA-BIP were successfully synthesized
- MA-BIP covalently bound to polymer matrix.
- A dramatic color change was observed after solutions of FeCl<sub>2</sub> and CoCl<sub>2</sub> were dropped onto the cured polymer.

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