

INTISARI

Modifikasi *Molecularly Imprinted Polymer* dan Doping untuk meningkatkan sensitivitas dan selektivitas sensor terpine dan amoniak berbasis *Quartz Crystal Microbalance*

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Sensitivitas dan selektivitas sensor menjadi dua parameter penting yang sangat menarik untuk terus dikaji. Dalam penelitian ini sensor berbasis *quartz crystal microbalance* (QCM) dimodifikasi *chitosan* (Cs) untuk mendeteksi *terpenoid* dan dengan *polyvinyl acetate* (PVAc) mendeteksi amoniak. Metode *molecular imprinted polymer* (MIP) diterapkan untuk meningkatkan selektivitas sensor, sementara itu doping *boric acid* (BA) dan *citric acid* (CA) digunakan meningkatkan sensitivitas sensor amoniak. Uji *scanning electron microscopy* (SEM) dan energi dispersive *X-Ray spectroscopy* (EDAX) digunakan mengkonfirmasi terbentuknya struktur *nanofiber*, sedangkan *fourier transform spectroscopy Infrared* (FTIR) digunakan mengkonfirmasi terjadinya pelepasan *template* (*terpenoid* atau amoniak). Selain sensitivitas dan selektivitas, karakteristik lain dari sensor yang diamati mencakup linieritas, stabilitas, waktu respons, *limit of detection* (LoD) dan *limit of quantification* (LoQ). Pada sensor *terpenoid*, penerapan MIP meningkatkan sensitivitas sensor tiga kali lipat dibanding tanpa metode MIP, yakni masing-masing adalah $(41 \pm 4) \times 10^{-3}$ Hz/ppm terhadap *alpha-pinene* dan $(412 \pm 7) \times 10^{-2}$ Hz/ppm terhadap *gamma-terpinene*. Sama halnya sensor amoniak, penerapan metode MIP meningkatkan sensitivitas sensor tiga kali lipat dibanding tanpa metode MIP dengan penambahan doping BA dan CA, yakni $(243 \pm 2) \times 10^{-3}$ Hz/ppm dan $(356 \pm 9) \times 10^{-2}$ Hz/ppm. Karakteristik lainnya berupa koefisien determinasi, waktu respons, LoD dan LoQ, untuk sensor *alpha-pinene* adalah $(996 \pm 5) \times 10^{-3}$; 75s; (24 ± 1) ppm; dan (73 ± 3) ppm untuk sensor *gamma-terpinene* adalah $(98 \pm 23) \times 10^{-2}$; 83 s; (22 ± 4) ppm; dan (69 ± 11) ppm, untuk sensor amoniak doping 6BA adalah $(999 \pm 9) \times 10^{-3}$; 37 s; (27 ± 1) ppm; dan (31 ± 1) ppm, dan sensor amoniak doping CA $(99 \pm 26) \times 10^{-2}$; 36 s; $(22 \pm 0,3)$ ppm; dan (44 ± 11) ppm.

Kata kunci: Sensor, *Quartz Crystal Microbalance*, *Molecularly Imprinted Polymer*, *Chitosan*, Doping, *Terpenoid*, Amoniak

ABSTRACT

Enhancing sensitivity and selectivity of Quartz Crystal Microbalance-based terpenoid and Ammonia sensors with Molecularly Imprinted Polymer and doping modification

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The sensitivity and selectivity of sensors are crucial parameters that require continual investigation. This study employed quartz crystal microbalance (QCM)-based sensors, modified with *chitosan* (Cs) to detect terpenoid and with polyvinyl acetate (PVAc) to detect ammonia. To enhance sensor selectivity, the molecularly imprinted polymer (MIP) method was employed while doping with boric acid (BA) and citric acid (CA) was utilized to increase sensor sensitivity for ammonia sensor. Scanning electron microscopy (SEM) and energy dispersion X-Ray spectroscopy (EDAX) were used to confirm the *nanofiber* structure formation, while Fourier transforms Infrared spectroscopy (FTIR) was employed to verify template release (terpenoid and ammonia). In addition to sensitivity and selectivity, this study also assessed other sensor characteristics, including linearity, stability, response time, the limit of detection (LoD), and the limit of quantification (LoQ). Result showed that MIP application increased sensor sensitivity three-fold for terpenoid specifically $(41 \pm 4) \times 10^{-3}$ Hz/ppm for alpha-pinene and $(412 \pm 7) \times 10^{-2}$ Hz/ppm for gamma-terpinene. Meanwhile, for ammonia detection, MIP application increased sensor sensitivity three-fold, specifically $(243 \pm 2) \times 10^{-3}$ Hz/ppm and $(356 \pm 9) \times 10^{-2}$ Hz/ppm when using BA and CA doping, respectively. Other characteristics such as coefficient of determination, response time, LoD and LoQ for alpha-pinene sensor were $(996 \pm 5) \times 10^{-3}$, 75s; (24 ± 1) ppm; and (73 ± 3) ppm, while those gamma-terpinene sensors which were $(98 \pm 23) \times 10^{-2}$; 83 s; (22 ± 4) ppm; and (69 ± 11) ppm, respectively. For the ammonia sensor doping BA, the values were $(999 \pm 9) \times 10^{-3}$; 37 s; (27 ± 1) ppm; and (31 ± 1) ppm, and for ammonia doping CA, the values were $(99 \pm 26) \times 10^{-2}$; 36 s; $(22 \pm 0,3)$ ppm; and (44 ± 11) ppm.

Keyword: Sensor, Quartz Crystal Microbalance, Molecularly Imprinted Polymer, *Chitosan*, Doping, Terpenoid, Ammonia.