# Pengembangan fotokatalis berbasis titania nanotube array dan aplikasinya untuk produksi hidrogen = Development of titania nanotube arrays based photocatalyst and its application for the production of hydrogen

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Abstrak

[<b>ABSTRAK</b><br>
Sintesis TiO2 bermorfologi nanotube array bentuk film (TNTAs) telah dilakukan dengan proses anodisasi logam Ti dalam larutan elektrolit gliserol yang mengandung NH4F, dilanjutkan dengan annealing untuk membuat fasa kristal dari TNTAs. Optimasi berbagai parameter meliputi variasi kadar air dalam larutan elektrolit, perlakuan annealing, penambahan NaBF4, metode dan lama pengadukan serta variasi loading dan metode dalam penambahan dopan logam Pt. Hasil SEM/FESEM menunjukkan bahwa TNTAs berhasil disintesis dengan tube yang rapi, tegak lurus dan mempunyai kisaran diameter dalam antara 49-205 nm, tebal dinding 11-33 nm serta panjang 530-2577 nm. Annealing dengan H2/Ar merupakan cara yang efisien untuk memasukkan dopan C, N dan B dalam matrik TNTAs secara insitu saat anodisasi, sehingga diperoleh penurunan energi band gap sampai pada kisaran 2,20?3,10 eV. Kebanyakan TNTAs berfasa anatase dengan ukuran kristal dari 18?33 nm. TNTAs yang disintesis pada kadar air 25% volume dan annealing dengan 20% H2/Ar merupakan fotokatalis optimal yang menghasilkan kerapatan arus tertinggi. Uji TNTAs untuk memproduksi hidrogen menggunakan gliserol sebagai sacrificial agent. Penambahan 5 mM NaBF4 selama anodisasi menghasilan TNTAs termodifikasi yang mampu menghambat laju rekombinasi elektron-hole sehingga dapat meningkatkan produksi hidrogen sebesar 32 %. Penambahan dopan Pt sebagai electron trapper secara fotodeposisi pada TNTAs hasil anodisasi ultrasonik mampu menghasilkan hidrogen dari larutan gliserol sebesar lima kali lebih tinggi dibandingkan tanpa penambahan Pt.;
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<b>ABSTRACT</b><br>
Synthesis of TiO2 nanotube array (TNTAs) has been performed by anodization process of Ti metal in the glycerol electrolyte solution containing NH4F followed by annealing to induce crystallization. Optimization some parameters was done including the variation of water content in the electrolyte solution, annealing atmosphere, addition of NaBF4, mode of mixing, as well as the variation of loading and the methods of Pt addition on the TNTAs. SEM/FESEM analysis showed that well ordered and vertically oriented of TNTAs with inner diameters of 49-205 nm, wall thicknesses from 11 to 33 nm and lengths from 530 to 2577 nm were synthesized. Annealing with H2/Ar is found to be an efficient method for introducing dopant C, N and B into the lattice of TNTAs via insitu anodization and, therefore, the reducing band gap in the range of 2,20?3,10 eV can be obtained. Most of TNTAs have anatase phase with the crystalline size from 18 to 33 nm. Water content of 25 v% and annealing under H2/Ar of as-synt TNTAs showed optimal condition in producing the highest photocurrent density. The photocatalytic hydrogen production test was performed with glycerol as a sacrificial agent. The addition of 5 mM NaBF4 during anodization resulted modified TNTAs that can reduce recombination of electron-hole and showed up 32 % improvement in hydrogen production. The photodeposition of Pt on the TNTAs that obtained from ultrasonic anodization can enhance

hydrogen production five times higher compare to the one with unplatinized TNTAs.;Synthesis of $TiO_2$ nanotube array (TNTAs) has been performed by anodization process of Ti metal in the glycerol electrolyte solution containing $NH_4F$ followed by annealing to induce crystallization. Optimization some parameters was done including the variation of water content in the electrolyte solution, annealing atmosphere, addition of $NaBF_4$, mode of mixing, as well as the variation of loading and the methods of Pt addition on the TNTAs. SEM/FESEM analysis showed that well ordered and vertically oriented of TNTAs with inner diameters of 49-205 nm, wall thicknesses from 11 to 33 nm and lengths from 530 to 2577 nm were synthesized. Annealing with $H_2$/Ar is found to be an efficient method for introducing dopant C, N and B into the lattice of TNTAs via insitu anodization and, therefore, the reducing band gap in the range of 2,20?3,10 eV can be obtained. Most of TNTAs have anatase phase with the crystalline size from 18 to 33 nm. Water content of 25 v% and annealing under $H_2$/Ar of as-synt TNTAs showed optimal condition in producing the highest photocurrent density. The photocatalytic hydrogen production test was performed with glycerol as a sacrificial agent. The addition of 5 mM $NaBF_4$ during anodization resulted modified TNTAs that can reduce recombination of electron-hole and showed up 32 % improvement in hydrogen production. The photodeposition of Pt on the TNTAs that obtained from ultrasonic anodization can enhance hydrogen production five times higher compare to the one with unplatinized TNTAs., Synthesis of $TiO_2$ nanotube array (TNTAs) has been performed by anodization process of Ti metal in the glycerol electrolyte solution containing $NH_4F$ followed by annealing to induce crystallization. Optimization some parameters was done including the variation of water content in the electrolyte solution, annealing atmosphere, addition of $NaBF_4$, mode of mixing, as well as the variation of loading and the methods of Pt addition on the TNTAs. SEM/FESEM analysis showed that well ordered and vertically oriented of TNTAs with inner diameters of 49-205 nm, wall thicknesses from 11 to 33 nm and lengths from 530 to 2577 nm were synthesized. Annealing with $H_2$/Ar is found to be an efficient method for introducing dopant C, N and B into the lattice of TNTAs via insitu anodization and, therefore, the reducing band gap in the range of 2,20–3,10 eV can be obtained. Most of TNTAs have anatase phase with the crystalline size from 18 to 33 nm. Water content of 25 v% and annealing under $H_2$/Ar of as-synt TNTAs showed optimal condition in producing the highest photocurrent density. The photocatalytic hydrogen production test was performed with glycerol as a sacrificial agent. The addition of 5 mM $NaBF_4$ during anodization resulted modified TNTAs that can reduce recombination of electron-hole and showed up 32 % improvement in hydrogen production. The photodeposition of Pt on the TNTAs that obtained from ultrasonic anodization can enhance hydrogen production five times higher compare to the one with unplatinized TNTAs.]