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Production of Photocatalytic Materials for Use in Plasma Methane Reforming

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Plasma catalysis can allow chemical reactions to occur at temperatures otherwise insufficient when using catalyst alone. Hydrogen is a zero emission fuel that can be obtained by plasma catalysis and is one of the most promising forthcoming fuel sources. This research focuses on combining catalysts and plasma generated in a packed bed dielectric barrier discharge reactor(PBR) to break down waste gases such as methane and carbon dioxide into hydrogen and carbon monoxide. Photocatalysts are employed due to their activation by UV light, which is naturally produced by plasma further enhancing the synergistic effect of the combined non-thermal plasma and catalyst. Magnetron sputtering is used to produce the photocatalysts in a novel way onto the surface of particulate substrates, prior to using the catalysts in the PBR to assess their use in plasma catalysis. Thin films of titania, tungsten doped titania and bismuth tungstate have been coated using unbalanced type II magnetrons onto various beads. The titania, doped titania and bismuth tungstate thin films were annealed in air in order to obtain their photocatalytic phase. These thin films were characterised by X-ray powder diffraction, Raman spectroscopy and scanning electron microscopy with EDX. The beads were also characterised through surface area measurements. Characterisation concluded that the thin films were amorphous following sputtering, and upon annealing photocatalytic anatase titania, anatase doped titania and russellite bismuth tungstate were produced. Photocatalytic testing using the acetone degradation method in a reaction cell where the irradiation of UV-visible light was used in order to investigate the effect of the photocatalytic films and substrates, which determined titania to be the most active. Finally testing of the coated beads within the PBR was undertaken to investigate the effect of the photocatalyst on the degradation of methane and the products produced.

Keywords
Non-thermal plasma
magnetron sputtering
plasma catalysis