THETA

Performance Coatings : Active Surface Nano-Technology

Air Purification by Heterogeneous Photocatalytic Oxidation with Envirocal: Thin Film Titanium Dioxide

The World Health Organization reports 2 million premature deaths each year can be attributed to the effects of urban outdoor and indoor air pollution. Nitrogen dioxide (NO_2) is a common combustion pollutant and powerful respiratory irritant. As with all major pollutants emitted by combustion it is linked to lung diseases such as emphysema, asthma and bronchitis and increased incidence of respiratory diseases. Studies have demonstrated that controlling relevant pollutants cost less than paying for the damage and remediation caused by the pollution. The average cost-benefit ratio has been reported to be 1 to 6 and with an upper limit of 1 to 44.

Photocatalytic titanium dioxide (TiO_2) provides one option for the reduction of air pollution. Titanium dioxide has a demonstrated ability for heterogeneous reduction of pollution gases and unlike common air purifiers, that use absorption materials to absorb and contain the gases, TiO_2 eliminates them without any further disposal and handling. Titanium dioxide is activated when a photon of light excites an electron into the conduction band of the TiO_2 producing its photocatalytic properties. The oxidizing potential allows a multitude of organic and inorganic molecules that can be oxidized in the presence of TiO_2 and light. **THETA Envirocal™** has been developed with these principles in mind.

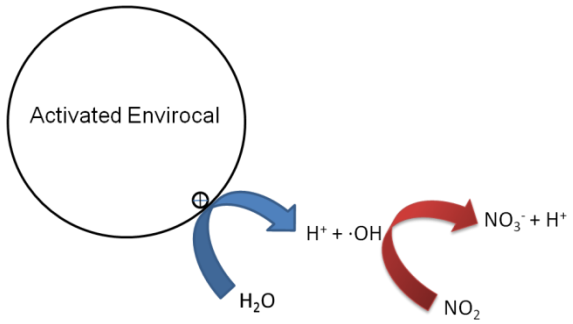

Figure1. Mechanism NO_2 conversion

The photocatalytic oxidation activity of TiO_2 can be utilised to convert nitrogen oxides to low concentration of nitrates, see Figure 1. Nitrates are water soluble and can be washed away by rain and subsequently extracted from the rain water. Here we report a new product, **Envirocal™**, and its ability to remove NO_2 from an air stream using visible and ultraviolet (UVA) light. Indeed **Envirocal™** showed remarkable ability to remove NO_2 compared to existing commercial TiO_2 coated products.

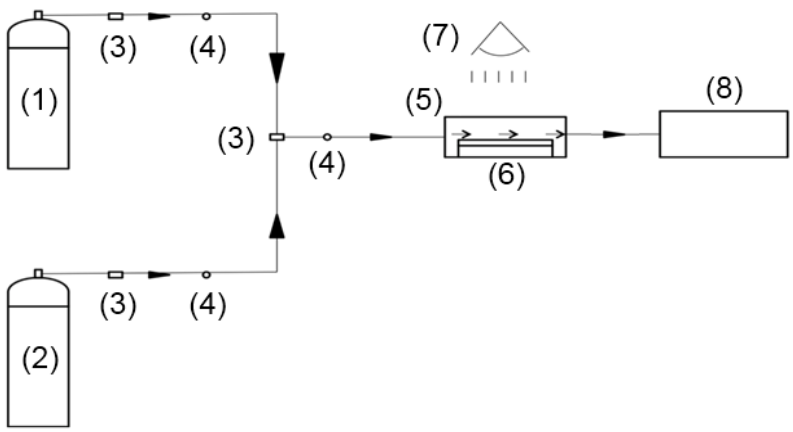

Figure 2. Schematic of the experimental set up: (1) NO_2 gas supply. (2) Compressed Air. (3) Mass flow controller. (4) Solenoid valve. (5) Reaction chamber. (6) TiO_2 coated substrate. (7) Light source. (8) Gas sensor.

Testing consisted of both ceramic and glass substrates were coated with **Envirocal™** where photocatalytic oxidation of NO_2 on our TiO_2-based films was explored under both simulated indoor and outdoor environments. Experiments were carried out using a standard procedure to produce repeatable results, see Figure 2. The design of the reactor vessel allowed NO_2 to enter the reactor, come into contact with the sample surface and then exit via the outlet where it is then analyzed by the WO_3 gas sensor.

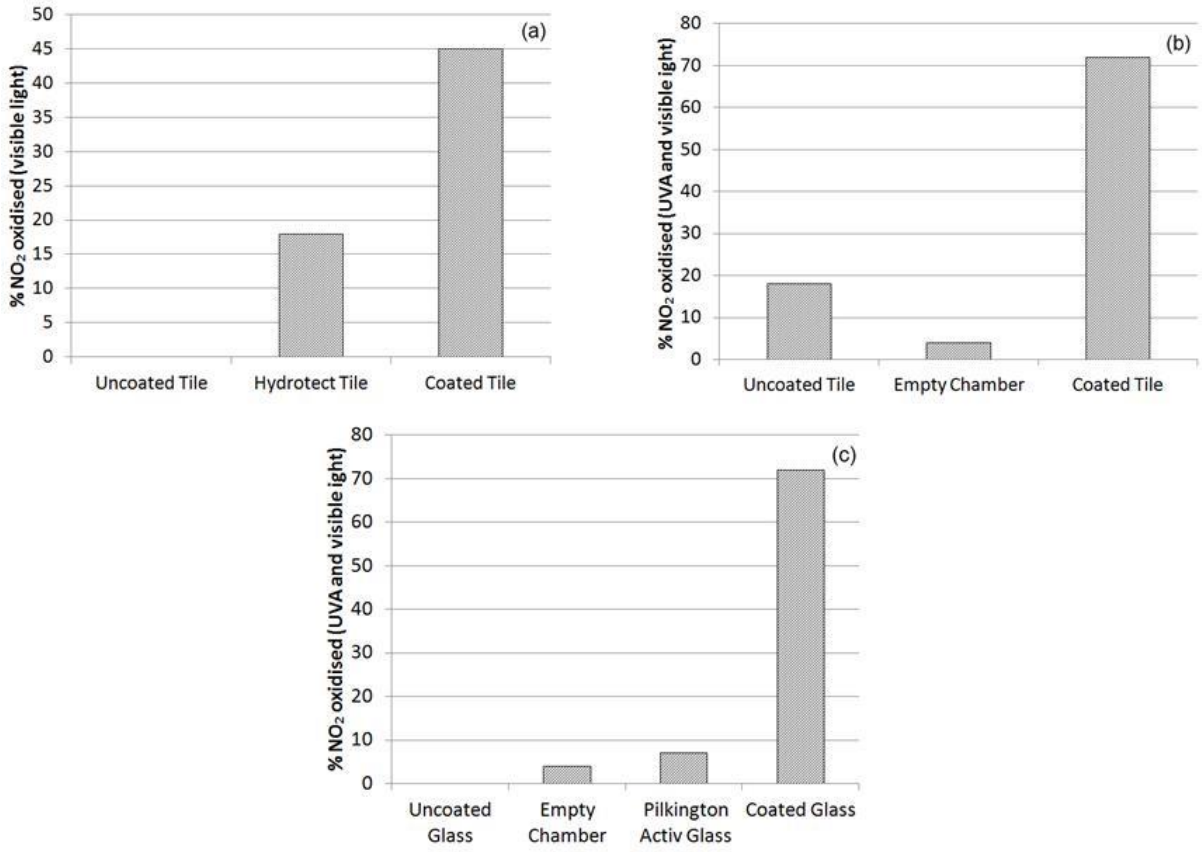

Fig 6. Bar charts showing the % NO_2 converted for tile coated samples using (a) visible light and (b) UVA and visible light and (c) glass coated samples using UVA and visible light.

The results illustrate an effective method of air purification through photocatalytic oxidation of gas pollutants for in-door and out-door use. **Envirocal's** outperformance of commercial competitors (Pilkington Activ™ and TOTO Hydrotect™) and significant conversion rates of 45% with visible light irradiation and 72% with UVA/visible light irradiation were demonstrated. Their ease of application on common building materials and high performance in out-door and indoor emulated environments demonstrate their industrial and commercial application.