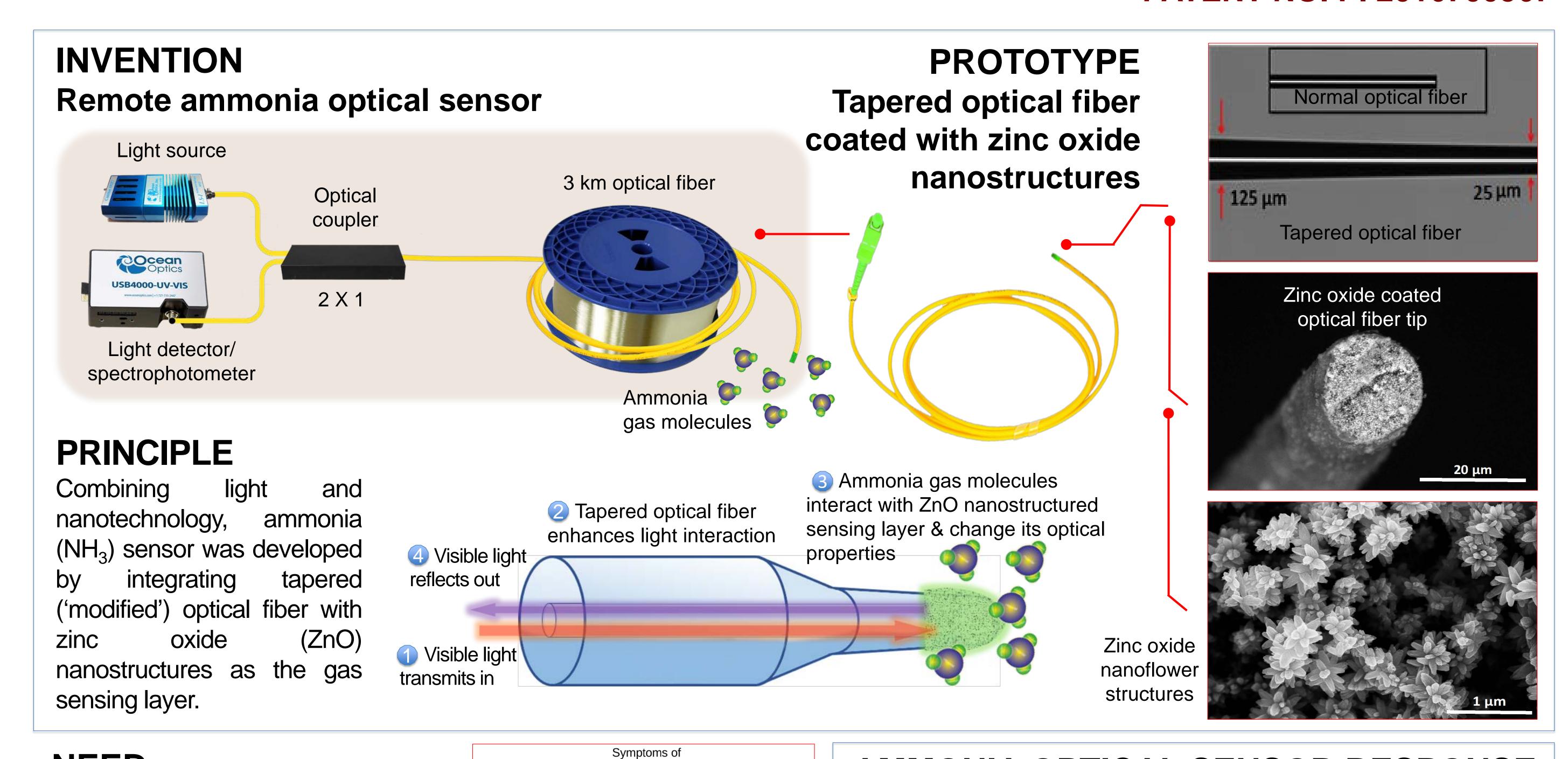


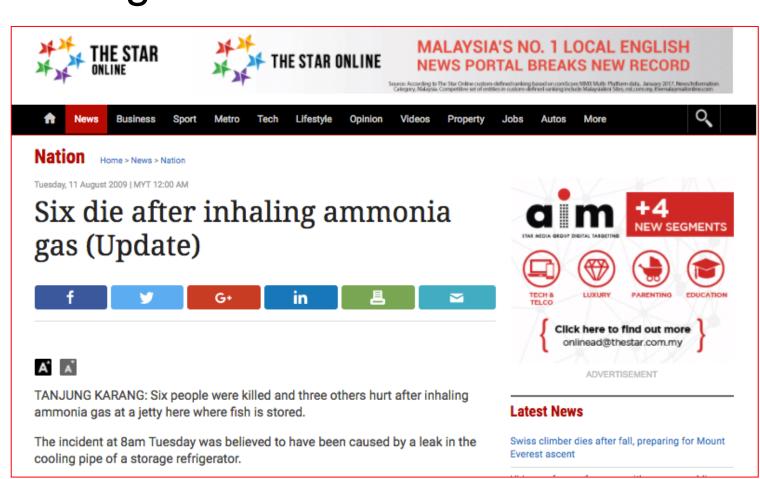
AMMONIA GAS SENSOR USING TAPERED OPTICAL FIBER COATED WITH ZINC OXIDE NANOSTRUCTURES

PATENT NO. PI 2016700567



NEED

Ammonia is widely used gas with a strong smell and high toxicity. The inhalation of this gas is deadly. Many fatal accidents are reported annually due to the ammonia leakages.



MARKET POTENTIAL

- Lethargy - Hypothermia Muscular/Neurologic — - Poor coordination - Papilledema - Dysdiadochokinesia - Hypotonia or Pulmonary hypertonia Shortness - Ataxia of breath - Tremor - Seizures Decorticate or decerebrate Enlargeposturing Source: Häggström, Mikael (2014) **STRAITSTIMES** Two killed in ammonia leak at Sipitang plant Share this story f y G By ROY GOH - August 16, 2016 @ 2:55pm SIPITANG: Two workers were killed in an ammonia leak mishap at a etronas Chemicals Group Berhad (PCG), in a statement, said five

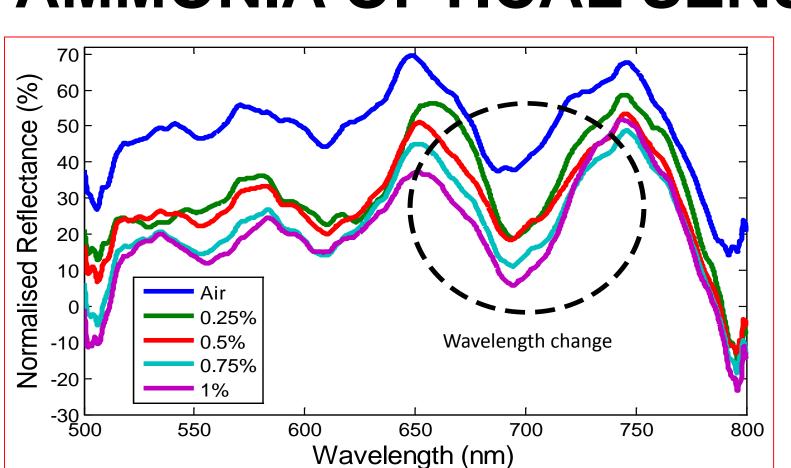
contractors were affected in the 9.30am incident at the Petronas Chemicals

*2016 Ammonia market price is typically USD300/ton

Hyperammonemia

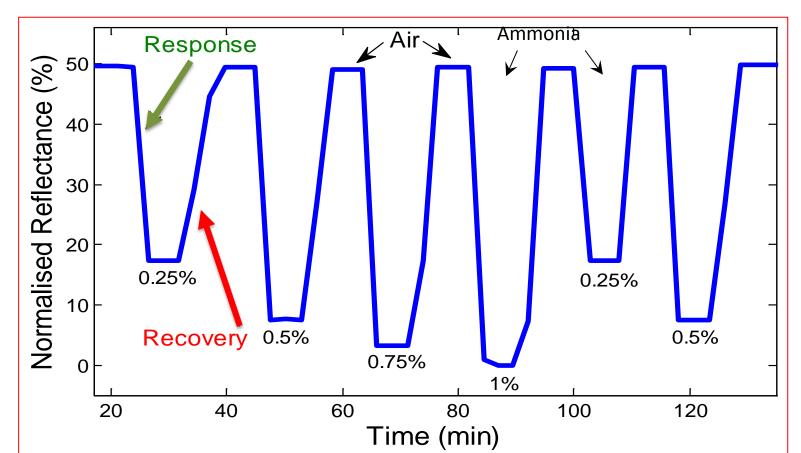
Ammonia World Production Remote environmental monitoring; (in metric tons) Oil and gas; Chemical process and logistic; 250,000 Agriculture 200,000 and fertilizer; Ammonia Pharma-Applications 100,000 ceuticals 50,000 and cleaning industries. Metal 2009 2010 2011 2012 2013 2014 2015

AMMONIA OPTICAL SENSOR RESPONSE



Tapered optical fiber sensor changes its intensity (reflectance) proportionally when exposed to different ammonia concentrations.

High surface area of ZnO nanostructures improves molecules interaction. Very fast response (60 s) and recovery (70 s) achieved at low temperature for remote optical fiber cable (3 km).



ADVANTAGES & STRENGTHS

Lightweight; Immune to electromagnetic interference (EMI); Suitable for volatile & flammable environment; Suitable for remote monitoring system (approx. 3 km); Room temperature operation; Energy saving; Competitive cost; High sensitivity and selectivity; Fast response and recovery (<one minute).

COMPETITOR TECHNOLOGY

Localised electrical sensor; Prone to EMI; Poor selectivity; High operating temperature (100 - 300°C); Limited environment.



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Source: SEC 2016

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Expertise: Optical Nanomaterials, Sensors and Communications