

Ammonia

The building-block



Company Bio

Tiger Optics was founded in 1999 and offers an array of laser-based instruments and electro-optical components. The company's solutions are used in markets varying from semiconductor fabrication to sustainable energy.

Ammonia addresses many needs and is perhaps most important as a building-block. The substance is a key component in many agricultural fertilisers while its chemical derivatives provide the foundation for an array of synthetic molecules, including dyes, pharmaceutical compounds, cosmetics, and vitamins.

Kimberly Reynolds, Product Manager for Gases & Chemicals at Tiger Optics, offered **gasworld** a run-down of its peculiar chemical properties. She described, "At ambient conditions, ammonia is a colourless gas with a sharp pungent odour. It is the primary gas released from "smelling salts", long used to stimulate nasal passages in an attempt to revive the unconscious."

Unlike the noble gases of recent gas reports, ammonia is far from inert. Reynolds explained, "At levels between 16 - 25% (Occupational Safety and Health Administration) or 15 - 28% (National Institute Occupational Safety and Health), ammonia is explosively ignitable and considered a flammability hazard." Furthermore, it is classified as toxic at levels above 300ppm.

Ammonia is lighter than air, with a molecular weight of 17.03 and as Reynolds pointed out, like many nitrogen-containing molecules, its single lone pair of electrons incite strong interactions when in contact with polar molecules, such as water. This, combined with its high solubility in water, explains ammonia's historical prevalence in cleaning solutions. Reynolds highlighted that the compound is even more volatile when exposed to strong oxidisers. There is particular potential for explosive reactions when mixed with air, hydrocarbons, alcohols, fluorine, chlorine, silver nitrate and some metals.

Nevertheless, unregulated use of ammonia

has become the primary contemporary concern regarding ammonia. Reynolds elucidated, "In the past 20 years there has been a rise in ammonia use for the illegal synthesis of methamphetamine. This has led to unfortunate outcomes, such as explosions and toxic events, due to the improper handling of the gas."

More conventionally, ammonia is used safely across a plethora of applications. Reynolds noted, "In the US it primarily serves agriculture when applied directly to croplands to add bio-accessible nitrogen to the soil. Ammonia also plays a role in the manufacturing processes of nylon, rayon acrylics, and polyurethane." Other demand sectors include waste water treatment schemes, and also industrial processes, where it can serve to neutralise acids.

Illuminating applications

The electronics industries are posing interesting growth applications for ammonia. Fred Conroy, Global Sales Director for Semi, LEDs, & Solar Applications at Tiger Optics, explained the logic to gasworld, "Atomic nitrogen can be extracted from ammonia at a lower temperature than from molecular nitrogen (N_2). This property makes ammonia conducive to a number of applications in the electronics industries that require a source of nitrogen."

"Ammonia is used as an etchant gas in semiconductor manufacturing and is often mixed with silane or dichlorosilane to make silicon nitride layers. The silicon nitride layers serve as insulators, chemical barriers, and dielectric layers on integrated circuits." Meanwhile ammonia offers a valuable source of nitrogen to the rapidly expanding compound industry. It aids gallium nitride (GaN) layers production, which is essential to manufacturing high-brightness LEDs.

Although these industries are at growth stage, they are already having a significant impact upon the ammonia industry. Lisa Bergson, Founder and CEO of Tiger Optics, described, "By now, moisture in ammonia has grown to represent 20% of Tiger's over \$30m of unit sales since inception. We are highly committed to this application and thrilled to see it take hold in the rapidly expanding LED market, where the purer the gas, the brighter the LEDs and the bigger the profit for our customers. As with the Semi market, which we have long served, LED makers and their suppliers are mainly concentrated in Asia."

Indeed, sector whispers indicate that demand for ammonia will only grow in forthcoming years, particularly if Tiger Optics' prediction is correct and HB LEDs are rolled-out into the residential setting. □