

Chemists use 'green chemistry' to produce amines, chemical compounds used widely in industry

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Chemists at UC Riverside have discovered an inexpensive, clean and quick way to prepare amines – nitrogen-containing organic compounds derived from ammonia that have wide industrial applications such as solvents, additives, anti-foam agents, corrosion inhibitors, detergents, dyes and bactericides.

Currently, industries produce amines in a costly two-step process that results in massive amounts of byproducts as waste.

"Although there are several methods to prepare amines on laboratory scales, most of them are not suitable for commodity chemical production not only because of the formation of waste materials but also because the cost of the starting substances used to prepare amines is high," said Guy Bertrand, a distinguished professor of chemistry, whose lab made the discovery.

Bertrand explained that, currently, companies use hydrochloric acid, a highly corrosive solution, to produce amines. To generate one ton of amines, manufacturers must discard three tons of byproducts, adding to the overall cost of production.

"Our 'green chemistry' method, however, produces no waste, which makes it inexpensive," Bertrand said. "Moreover, the reaction is a quick one-step reaction, and you need a tiny amount of a catalyst to do the

trick." (A catalyst is a substance which increases the rate of a chemical reaction without itself being used up in the reaction.)

Study results appear online in *Angewandte Chemie*. A print version of the [research paper](#) will appear soon in the journal as well.

The catalyst in question – a gold atom linked to a cyclic alkyl amino carbene or CAAC – is a ligand (a special molecule that binds to metals) that Bertrand's lab discovered in 2005.

The gold compound readily catalyzes the addition of ammonia – a colorless, pungent gas composed of nitrogen and hydrogen – to a number of organic compounds. One such chemical reaction involves ammonia combining with acetylene to produce an amine derivative; a carbon-nitrogen bond is created in this reaction.

"One of the greatest challenges in chemistry is to develop atom-efficient processes for the combination of ammonia with single organic molecules to create carbon-nitrogen bonds," Bertrand said. In atom-efficient processes, the amount of starting materials equals the amount of all products generated, with no atoms wasted.

More than 100 million tons of ammonia are produced annually in the world, and the production of amines similarly is huge. Essential to life as constituents of amino acids, amines occur in drugs and vitamins, and are used also to manufacture cosmetics, cleaning and crop protection agents, plastics, and coating resins.

"Our study paves the way for finding catalysts that mediate the addition of ammonia to simple alkenes, which are organic compounds containing a carbon-carbon double bond," Bertrand said. "This process is widely considered to be one of the ten greatest challenges for catalytic chemistry."

Source: University of California - Riverside

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