Trimethylaluminium

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(Redirected from Trimethylaluminum)

Trimethylaluminium is the chemical compound with the formula $Al_2(CH_3)_6$, abbreviated as Al_2Me_6, $(AlMe_3)_2$ or the abbreviation TMA. This pyrophoric, colorless liquid is an industrially important organoaluminium compound. It evolves white smoke (aluminium oxides) when the vapor is released into the air.

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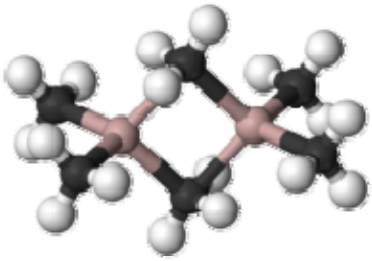
Structure and bonding

Al_2Me_6 exists as a dimer, analogous in structure and bonding to diborane. As with diborane, the metalloids are connected by a 3-center-2-electron bond: the shared methyl groups bridge between the two aluminium atoms. The Al-C(terminal) and Al-C (bridging) distances are 1.97 and 2.14 Å, respectively.[1] The carbon atoms of the bridging methyl groups are each surrounded by five neighbors: three hydrogen atoms and two aluminium atoms. The methyl groups interchange readily intramolecularly and intermolecularly.

3-Centered-2-electron bonds are an utterance of "electron-deficient" molecules and tend to reactions with Lewis bases that would give products consisting of 2-centered-2-electron bonds. For example upon treatment with amines gives adducts R_3N-$AlMe_3$. Another reaction that gives products that follow the octet rule is the reaction of Al_2Me_6 with aluminium trichloride to give $(AlMe_2Cl)_2$.

The species $AlMe_3$, which would feature an aluminium atom bonded to three methyl groups is unknown. VSEPR Theory predicts that such a molecule would have idealized threefold symmetry, as observed in BMe_3.

Trimethylaluminium	
	
IUPAC name	
trimethylalumane	
Other names	
Trimethylaluminium; aluminium trimethyl	
Identifiers	
CAS number	75-24-1 ✓
PubChem	16682925
ChemSpider	10606585 ✓
SMILES	
C[Al](C)C	
InChI	
InChI=1S/3CH3.Al/h3*1H3; Key: JLTRXTDYQLMHGR-UHFFFAOYSA-N	
InChI=1/3CH3.Al/h3*1H3;/rC3H9Al/c1-4(2)3/h1-3H3 Key: JLTRXTDYQLMHGR-MZZUXTGEAJ	
Properties	
Molecular formula	$C_6H_{18}Al_2$
Molar mass	144.18 g/mol
Appearance	Colorless liquid
Density	0.752 g/mL
Melting point	15 °C
Boiling point	125 °C
Hazards	
Main hazards	Pyrophoric
✓(what is this?) (verify) Except where noted otherwise, data are given for materials in their standard state (at 25 °C, 100 kPa)	
Infobox references	

Synthesis and applications

TMA is prepared via a two-step process that can be summarized as follows:

$$2\ Al + 6\ CH_3Cl + 6\ Na \rightarrow Al_2(CH_3)_6 + 6\ NaCl$$

TMA is mainly used for the production of methylaluminoxane, an activator for Ziegler-Natta catalysts for olefin polymerisation. TMA is also employed as a methylation agent. Tebbe's reagent, which is used for the methylenation of esters and ketones, is prepared from TMA. TMA is often released from sounding rockets as a tracer in studies of upper atmospheric wind patterns.

TMA is also used in semiconductor fabrication to grow thin film, high-k dielectrics such as Al_2O_3 via the processes of Chemical Vapor Deposition or Atomic Layer Deposition.

TMA forms a complex with the tertiary amine DABCO, which is safer to handle than TMA itself.[2]

In combination with Cp_2ZrCl_2 (zirconocene dichloride), the $(CH_3)_2Al\text{-}CH_3$ adds "across" alkynes to give vinyl aluminium species that are useful in organic synthesis in a reaction known as carboalumination.[3]

Semiconductor grade TMA

TMA is the preferred metalorganic source for metalorganic vapour phase epitaxy (MOVPE) of aluminium-containing compound semiconductors, such as AlAs, AlN, AlP, AlSb, AlGaAs, AlInGaAs, AlInGaP, AlGaN, AlInGaN, AlInGaNP etc. Criteria for TMA quality focus on (a) elemental impurites, (b) oxygenated and organic impurities.

References

1. ^ Holleman, A. F.; Wiberg, E. "Inorganic Chemistry" Academic Press: San Diego, 2001. ISBN 0-12-352651-5.
2. ^ Biswas, K.; Prieto, O.; Goldsmith, P. J.Woodward, S. (2005). "Remarkably Stable $(Me_3Al)_2$DABCO and Stereoselective Nickel-Catalyzed AlR_3 (R = Me, Et) Additions to Aldehydes". *Angewandte Chemie International Edition* **44** (15): 2232–2234. doi:10.1002/anie.200462569 (http://dx.doi.org/10.1002%2Fanie.200462569) . PMID 15768433 (http://www.ncbi.nlm.nih.gov/pubmed/15768433) .
3. ^ Negishi, E.; Matsushita, H., "Palladium-Catalyzed Synthesis of 1,4-Dienes by Allylation of Alkenylalane: α-Farnesene [1,3,6,10-Dodecatetraene, 3,7,11-trimethyl-]" (http://www.orgsyn.org/orgsyn/orgsyn/prepContent.asp?prep=cv7p0245) , *Org. Synth.*, http://www.orgsyn.org/orgsyn/orgsyn/prepContent.asp?prep=cv7p0245; *Coll. Vol.* **7**: 245

External links

- Informative commercial link to Trimethylaluminum and other metalorganics. (http://electronicmaterials.rohmhaas.com/products/Default.asp?product=Trimethylaluminum)
- Interactive Vapor Pressure Chart for metalorganics (http://electronicmaterials.rohmhaas.com/businesses/micro/metalorganics/vapor.asp?caid=291) .

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