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1, 2, 3 - TRIAZOLE AND ITS APPLICATIONS IN VARIOUS FIELDS

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Abstract

A triazole refers to any of the heterocyclic compounds with molecular formula $C_2H_3N_3$, having a five-membered ring of two carbon atoms and three nitrogen atoms. The 1,2,3-triazole moiety has attracted increasing attention because of their potential utility in bioconjugation, agriculture, synthetic, chemical synthesis, medicinal chemistry and supramolecular chemistry. Copper(I) catalyzed 1,3-dipolar cycloaddition reaction between organic azide and terminal alkyne, discovered by sharpless and meldal has become lately a powerful tool for the efficient construction of 1,2,3-triazole moiety. The present paper will focus mainly on the applications of the 1,2,3-triazole moiety in various fields.

Keywords *1,2,3-triazoles, applications, Copper-Catalyzed, Huisgen cycloaddition*

Introduction

A triazole refers to any of the heterocyclic compounds with molecular formula $C_2H_3N_3$, having a five-membered ring of two carbon atoms and three nitrogen atoms. There are two sets

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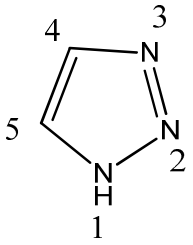
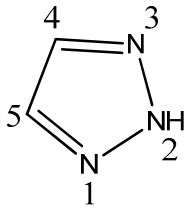
of isomers that differ in the relative positions of the three nitrogen atoms. Each of these has two tautomers that differ by which nitrogen has hydrogen bonded to it:

1. **1,2,3-Triazole**

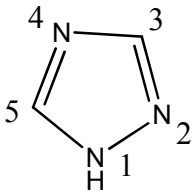


1*H*-1,2,3-triazole

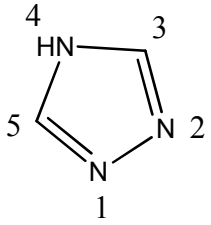


2*H*-1,2,3-triazole

2. **1,2,4-Triazole**



1*H*-1,2,4-triazole



4*H*-1,2,4-triazole

1,2,3-Triazole is one of a pair of isomeric chemical compounds with molecular formula $C_2H_3N_3$, called triazoles, which have a five-membered ring of two carbon atoms and three nitrogen atoms. 1,2,3-Triazole is a basic aromatic heterocycle.[1]

Substituted 1,2,3-triazoles can be produced using the azide alkyne Huisgen cycloaddition in which an azide and an alkyne undergo a 1,3-dipolar cycloaddition reaction. It has a surprisingly stable structure compared to other organic compounds with three adjacent nitrogen atoms.

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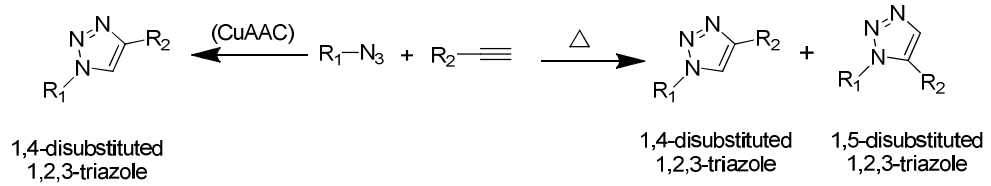
However, flash vacuum pyrolysis at 500 °C leads to loss of molecular nitrogen (N_2) to produce aziridine. Certain triazoles are relatively easy to cleave due to so-called ring-chain tautomerism. One manifestation is found in the Dimroth rearrangement.

Synthesis of 1,2,3-triazoles

The term *click chemistry* was first coined by Kolb, Finn, and Sharpless in a review article published in 2001.[2] Click chemistry includes extremely exothermic bond formations such as cycloaddition reactions, nucleophilic ring opening, addition reactions to carbon-carbon multiple bonds and non-aldol-type carbonyl reactions.[3] The Cu(I)-catalyzed [3+2] azide alkyne cycloaddition reaction (CuAAC) reported by the group of Sharpless[3] and Meldal[4] is one of the most reliable click reactions has been used synonymously with click chemistry in recent literature (Scheme).[5-7] It transforms terminal alkyne and organic azide exclusively into the corresponding 1,4-disubstituted 1,2,3-triazole. This metal catalyzed method has many benefits over Huisgen cycloaddition reactions of azide with terminal alkyne.[8-10] The latter technique yields a mixture of 1,4- and 1,5-regioisomers. Further, the reaction required a strong electron withdrawing substituent either on azide or on alkyne under high temperature (80-120 °C) and prolonged reaction period.[11] Moreover; this click reaction is associated with a number of benefits including great efficiency, regioselectivity, and compatibility with reaction conditions. The special property of the 1,4-disubstituted 1,2,3-triazole ring in terms of its capability to participate in hydrogen bond and dipole-dipole interactions has made click chemistry even more useful for a variety of applications.[12]



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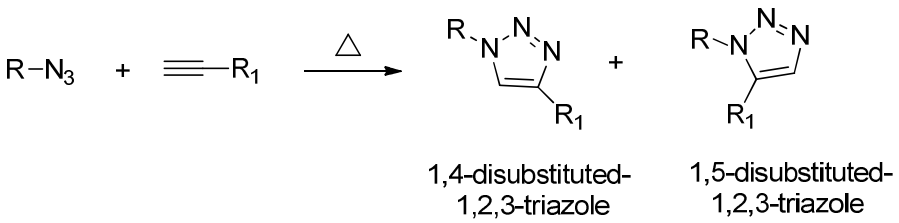
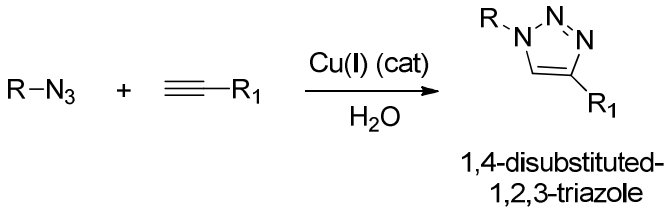
Scheme 1: Thermal and copper catalyzed Huisgen cycloaddition between azide with terminal alkyne.

Name Reactions of 1,2,3-Triazole



Scheme 2: Huisgen Azide-Alkyne 1,3-Dipolar Cycloaddition



Scheme 3: Copper-Catalyzed Azide-Alkyne Cycloaddition (CuAAC)

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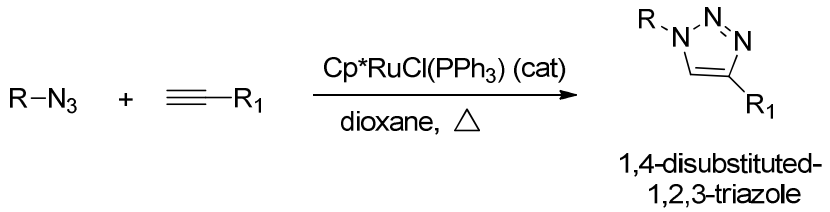

Scheme 4: Ruthenium-Catalyzed Azide-Alkyne Cycloaddition (RuAAC)

Derivatives

The triazole antifungal drugs: The triazole antifungal drugs include fluconazole, isavuconazole, itraconazole, voriconazole, pramiconazole, ravuconazole, and posaconazole.

The triazole plant protection fungicides: The triazole plant protection fungicides include epoxiconazole, triadimenol, propiconazole, prothioconazole, metco nazole, cyproconazole, tebuconazole, flusilazole and paclobutrazol.

The triazole plant growth retardants: Paclobutrazol and uniconazole are used as plant growth retardants. [13]

Benzotriazole is used in chemical photography as a restrainer and fog-suppressant.

Applications of Triazoles

The copper(I)-catalyzed click reactions has received much attention because of its numerous applications in various fields. Some important applications of 1,2,3-triazoles are given below:

1. **Importance in agriculture**

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Due to spreading resistance of plant pathogens towards fungicides of the strobilurin class,[14] control of fungi such as *Septoria tritici* or *Gibberella zeae*[15] relies heavily on triazoles. Food, like store bought potatoes, contain retardants such as triazole or tetcyclacis.[16]

2. Importance in chemical synthesis

The azide alkyne Huisgen cycloaddition is a mild and selective reaction that gives 1,2,3-triazoles as products. The reaction has been widely used in bioorthogonal chemistry and in organic synthesis. Triazoles are relatively stable functional groups and triazole linkages can be used in a variety of applications (for example, replacing the phosphate backbone of DNA.[17])

3. Applications in Medicinal Chemistry

1,2,3-Triazoles are main class of heterocycles because of their extensive range of biological properties such as antimicrobial[18], anticancer[19], anitubercular[20], anti-HIV[21], antimalarial[22], antibacterial[23], antifungal[24], antiviral[25], antidiabetic[26], antiallergic[27] behavior.

1,2,3-Triazole finds use in research as a building block for more complex chemical compounds, including pharmaceutical drugs such as tazobactam.

Therefore,many researchers have synthesized these compounds as target structures and evaluated their biological activities. These observations help the researchers for the development of new triazole compounds with enhanced biological activities.

4. Applications in Supramolecular Chemistry

Poly-1,2,3-triazole-based functional materials have shown more widespread applications (owing to their superior properties), including DNA chemistry, self-assembly, surface modification, supramolecular chemistry, combination chemistry, and dendrimer chemistry, as well as functional macromolecules [28]

5. Applications in ionic recognition/sensing

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Recognition of anions[29], cations[30] and neutral molecules[31] have attracted considerable attention owing to their applications in chemistry and biology. Anions and cations are vital in carrying out many biochemical and physiological operations in living systems. The designing and synthesis of receptors for cations and anions have been a major area of interest in the field of supramolecular chemistry. Recently, 1,2,3-triazoles has been regarded as a structural motif for the recognition of anions and cations[32]. The N(3) atom and C atom of carbamate-linked 1,4-disubstituted 1,2,3-triazole act as a hydrogen bond acceptor. The 1,2,3-triazole ring is associated with high chemical stability, large dipole moment, heteroaromatic character, hydrogen bond donating and hydrogen bond accepting abilities, enable it to interact productively to various anions, cations and neutral molecules.

They are also used as light stabilizers[33], fluorescence chemosensors[34] and corrosion retarding agents[35].

Conclusion

The 1,2,3-triazole moiety has attracted increasing attention because of their potential utility in bioconjugation, agriculture, synthetic, chemical synthesis, medicinal chemistry and supramolecular chemistry. Copper(I) catalyzed 1,3-dipolar cycloaddition reaction between organic azide and terminal alkyne, discovered by sharpless and meldal has become lately a powerful tool for the efficient construction of 1,2,3-triazole moiety. The present paper will focus mainly on the applications of the 1,2,3-triazole moiety in various fields.

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