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NAMES FOR MUONIUM ATOMS AND IONS

(Provisional Recommendations 2000)

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1. INTRODUCTION

Although chemical reactions of muonium atoms have been studied for more than two decades, the nomenclature of muonium and related species has not been addressed by IUPAC. The name 'muon' is used in physics for the species that belong to the lepton family and that are designated with the symbols μ^+ and μ^-, each having a mass 207 times that of the electron. When a negative muon replaces an electron in the 1s orbital of an atom, then this atom is called a 'muonic' atom: $H^+\mu^-$ is 'muonic hydrogen'. Replacement of an electron by a muon in other atoms is possible. Negative muons have been less well studied than positive muons, which are formed as energetic, polarized beams at specialized facilities. The positive muon can abstract an electron near the end of the radiation track and the combination of positive muon and electron mimics the reactivity of the hydrogen atom [1]. For this combination the name 'muonium' has been used [1, 2]. Were a negative muon to replace an electron in muonium the name would be 'muonic muonium' ($\mu^+\mu^-$).

2. NOMENCLATURE

A summary of muonium nomenclature is given in Table 1.

Table 1 Comparison of names for muonium species with ^{1}H equivalent [3].

muonium equivalent			^{1}H equivalent		
particle	name	symbol	particle	name	symbol
μ^+	muon	Mu^+	p^+	proton	H^+
μ^+e^-	muonium	$Mu^\bullet$	p^+e^-	protium	$H^\bullet$
$\mu^+(e^-)_2$	muonide	Mu^-	$p^+(e^-)_2$	protide	H^-

These recommendations lead to the following related terms:

'muonido' indicates muonium as a ligand (*cf.* hydrido);

'muono' is used in substitutive nomenclature (*cf.* deutero);

'muonation' is the equivalent of protonation, and

'muoniation' represents the process of replacement of hydrogen by muonium.

Examples:

1. MuCl is named 'muonium chloride', which yields positive muons and chloride ions upon dissociation.

2. CH_3Mu, muonomethane, is the product of the muoniation of methane.

3. NaMu is named 'sodium muonide'.

4. ^{1}HMuO is named 'muonium protium oxide'; for an unspecified isotope of hydrogen the name changes to 'hydrogen muonium oxide'. MuO^- is named 'muoniumoxide(1−)'.

5. As the systematic name of $^1H_2$ is diprotium, ^{1}HMu is named 'muonium protium', and HMu 'hydrogen muonium'.

6. Addition of muonium to a double bond results in the formation of a radical. For example, the reaction of $Mu^\bullet$ with benzene would yield the radical '6-muonocyclohexa-2,4-dien-1-yl'.

REFERENCES AND NOTES

1. D.C. Walker. *Acc. Chem. Res.* **18**, 167-173 (1985).
2. IUPAC. *Quantities, Units and Symbols in Physical Chemistry*, 2nd Ed., I.T. Mills, T. Cvitaš, K. Homann, N. Kallay and K. Kuchitsu (Eds.) Blackwell Scientific Publications, Oxford, 1993, p. 93. Please note that in the 1988 edition of this book muonium is incorrectly defined as a particle with the composition $\mu^+\mu^-$.
3. *Pure Appl. Chem.* **60**, 1115-1116 (1988).