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Inorganica Chimica Acta 360 (2007) 3719–3726
Inorganica Chimica Acta
www.elsevier.com/locate/ica

# Solid state and solution NMR, X-ray and antimicrobial studies of 1:1 and 2:1 complexes of silver(I) cyanide with alkanediamine ligands

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Received 23 January 2007; received in revised form 22 April 2007; accepted 24 April 2007
Available online 30 April 2007

**Abstract**

Several complexes of AgCN with alkanediamine ligands (where the ligands are ethylenediamine, propane-1,3-diamine, butane-1,4-diamine, *N*,*N*′-dimethyl-ethylenediamine, *N*,*N*′-di-*iso*-propyl-ethylenediamine, etc.) have been synthesized and structurally characterized. In these species, alkanediamine ligands act as chelating ligands. The X-ray structure of the complex cyano-(*N*,*N*′-di-*iso*-propyl-ethylenediamine)–silver(I) was determined. These complexes have been also characterized by IR, solution as well as solid-state NMR studies. There are two types of IR absorptions observed for mono and dinuclear complexes. For the mono nuclear complexes, a sharp CN band is observed between 2111 and 2131 $cm^{-1}$ range, whereas for binuclear complexes the bands are in the range 2136–2140 $cm^{-1}$. The effect of the size of the ligands as well as their substituents is discussed. The antimicrobial activity studies of AgCN and its complexes show that the former exhibits substantial antibacterial activities compared to its complexes.


*Keywords:* AgCN–alkanediamine complexes; CPMAS NMR studies; X-ray crystal structure; Antimicrobial activity

## 1. Introduction

Applications of transition metal cyanides are widespread in chemistry, with recent interest in such diverse areas as molecular magnetism [1–4] and the synthesis of porous supramolecular assemblies [5–7]. In 1999, Bowmaker et al. published powder neutron diffraction structures of AuCN and AgCN and found that both systems exist as ''infinite'' linear chains of alternating metal and cyanide moieties. Silver cyanide was found to be translationally disordered, with adjacent chains displaced along their long axis relative to each other [8].

The coordination chemistry of alkanediamines is a subject of interest from different points of view [5–7,9]. These bidentate ligands can adopt either a bridging or chelating bonding mode. The interaction of Ag(I) with such σ-donor ligands was extensively studied by Pretsch et al. [10]. It was found that the chelate bonding mode was observed for the two-carbon alkane chains while the longer three and four-carbon chain diamines adopt the bridging mode.

In this paper, we present the results of the synthesis, solution and solid-state NMR studies, IR spectra and the antimicrobial studies of three new complexes along with the X-ray structure of the complex cyano(*N*,*N*′-di-*iso*-propylethylenediamine)–silver(I). The NMR and antimicrobial studies were performed on a series of other Ag(I)–alkanediamine complexes.

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doi:10.1016/j.ica.2007.04.036