

The use of amino acids in gold leaching; the FTIR and DFT approach

Tapfuma, A; Akdogan, G; Luckay, RC; Lopis, Anton S; Tadie, M

Abstract

The drive towards environmentally benign gold mining, often referred to as 'green mining', has gained momentum as a response to the escalating environmental concerns linked to cyanide usage in gold processing. Recently, amino acids have emerged as promising gold-leaching lixivants, offering advantages over the conventional cyanide methods. However, the bulk of research has predominantly focused on glycine, the first member of the alpha-amino acid group, leaving other amino acids unresearched. In a novel approach, this study shifts the focus to the use of alanine in gold leaching and associated gold-alanine complexation at both experimental and computational levels, coupled with dissolution work. Experimental analyses through Fourier Transform Infrared Spectroscopy (FTIR) showed that alanine, in either its neutral or deprotonated state, effectively bonds with gold through donor electrons from nitrogen (N) and oxygen (O) at the amine and carboxylic end, respectively. In addition, the complexes of deprotonated alanine, compared to neutral (zwitterion) alanine, exhibited higher characteristic peak shifts during complexation. Furthermore, quantum computational calculations revealed that deprotonated alanine formed the most stable gold complex compared to the neutral amino acid, characterized by the N-Au-N bonding. The complexation of gold and deprotonated alanine exhibits the larger complexation energy compared to the neutral form, as revealed by the computational analyses. The third part of the study involved the dissolution of gold using both the deprotonated and neutral molecules, and the results showed that gold dissolution was more pronounced using the deprotonated molecule. This study showed that the gold dissolution is connected to the complexation as shown by FTIR and DFT, and this can be seen in high gold dissolution corresponding to a high peak shift at deprotonation pH and high complexation energy for the gold with the deprotonated alanine compared to the neutral alanine. Lastly, the study suggests that deprotonated alanine can be a possible lixiviant to leach gold from secondary gold sources such as tailings.