Spectroscopy and Electrochemistry of Tantalum(V) in 1-Butyl-1-methylpyrrolidinium Trifluoromethanesulfonate

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FTIR spectroscopic and electrochemical characterizations of tantalum(V) in 1-butyl-1-methylpyrrolidinium trifluoromethanesulfonate (Pyr_{14}TFMS)-$TaCl_5$ ionic liquids are performed with 5, 15, and 35 mol% $TaCl_5$ as the media for potential electrochemical application. On the basis of FTIR spectra the electrochemical active species are identified as follows: $[TaOCl_4]^-$, $[TaOCl_5]^{2-}$, $[TaCl_5F]^-$, and $[TaCl_5F_2]^{2-}$. The dominant species are the oxochloride complexes of tantalum(V).

Cyclic voltammograms of Pyr_{14}TFMS-$TaCl_5$ mixtures at 80 °C exhibit three reduction peaks: at -0.8 V, -0.9 V, and -2.4 V. The first reduction peak corresponds to the reduction of the oxochloride species of tantalum(V), the second is assigned to the reduction of the mixed chloride-fluoride species of tantalum(V), and the third peak to the further reduction of tantalum.

The spectroscopic data confirm the suggestion that oxochloride complexes of tantalum(V) become the dominant species in ionic liquids with the oxygen-containing functional group $[CF_3SO_3]^-$, possibly restricting the process of tantalum metal deposition from these ionic liquids.

Key words: Tantalum(V) Chloride; 1-Butyl-1-methylpyrrolidinium Trifluoromethanesulfonate; Ionic Liquids; Spectroscopy; Electrochemistry.