Investigation of Fluorinated Copper and Gold Alkoxides as Precursors for Atomic Layer Deposition

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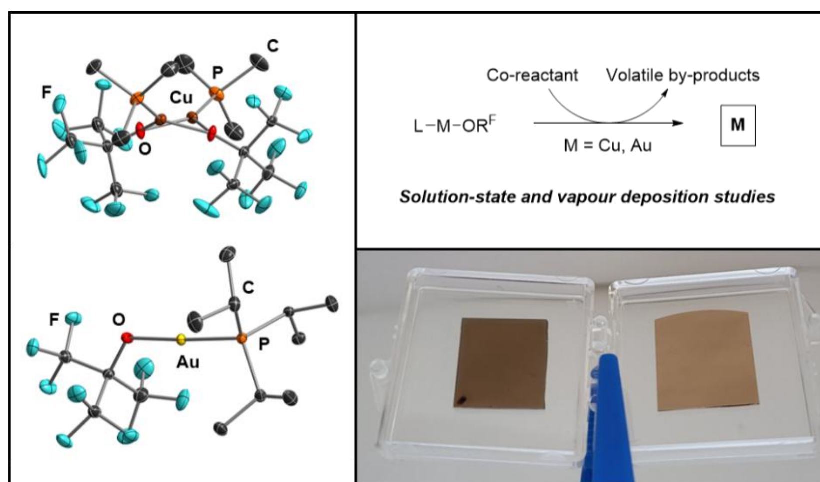
This research focuses on the development of new precursors and processes for thermal atomic layer deposition (ALD) of elemental copper and gold thin films. Most previously reported copper thermal ALD processes require deposition temperatures in the range of 100-500 °C, which can result in agglomeration and discontinuous ultra-thin films.[1] Meanwhile, there have only been three reported processes[2] for Au thermal ALD – two of these use ozone (O_3) as a co-reactant, which limits substrate compatibility, while the minimum deposition temperature for the third process using [$AuCl(PEt_3)$] with 1,4-bis(trimethylgermyl)-1,4-dihydropyrazine is limited by the volatility of the precursor and co-reactant. Thus, precursors which offer increased reactivity, thermal stability and volatility compared to those currently available, as well as the development of new reaction chemistries which might facilitate deposition at temperatures lower than previously reported, are of particular significance.

Herein we present a new family of fluorinated alkoxides, [$\{M(OR^F)(L)\}_n$] (M = Cu, Au; OR^F = fluorinated alkoxide; L = PR_3, CNR), as potential precursors for thermal ALD of Cu and Au. Complexes were synthesized by straightforward and scalable methodologies, and were crystallographically and spectroscopically characterized. The thermal properties of these complexes were evaluated, displaying a wide range of thermal stability and volatility, with some precursors possessing the required characteristics for use in ALD. Solution-state reactions of these precursors with various ALD co-reactants support the thermodynamic feasibility of potential ALD reaction chemistry, yielding the target metal and volatile by-products. Select precursors were chosen for preliminary studies on a custom-built ALD reactor, leading to deposition of metallic thin films.



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