Ambient Oxidation Dynamics of Copper Antimicrobial Surfaces

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Motivation

In recent years, increased resistance of pathogens to traditional antibiotics has mounted serious health concerns. The development of novel, improved, and non-selective antimicrobial agents is necessary to combat the further spread of infectious disease and protect public health from antibiotic resistant superbugs [1]. Copper possesses natural antimicrobial activity which can be enhanced by creating nanoscale surface features and used in various applications to address the escalating challenges posed by bacterial resistance and the proliferation of infectious diseases.

This work aims **to quantify oxide layer thickness and delineate the growth kinetics of cuprous oxide under ambient conditions,** providing crucial insights into the response of copper substrates to ambient environmental factors. Understanding surface oxidation dynamics is pivotal in evaluating the long-term antimicrobial efficacy of copper and optimizing its applications in combating infectious diseases.

Methods

Grow oxide layer at constant temperature and measure changes in cuprous oxide layer thickness using spectroscopic ellipsometry for samples with different crystal orientations.

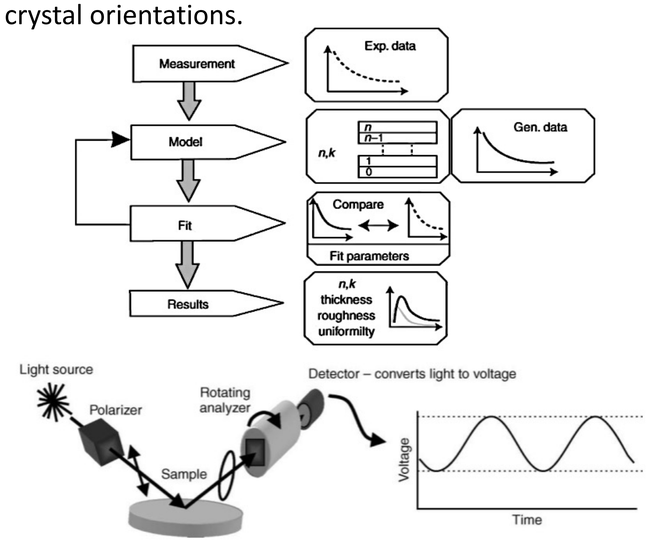

Figure 1: Spectroscopic ellipsometry overview [2].

Experimental Results

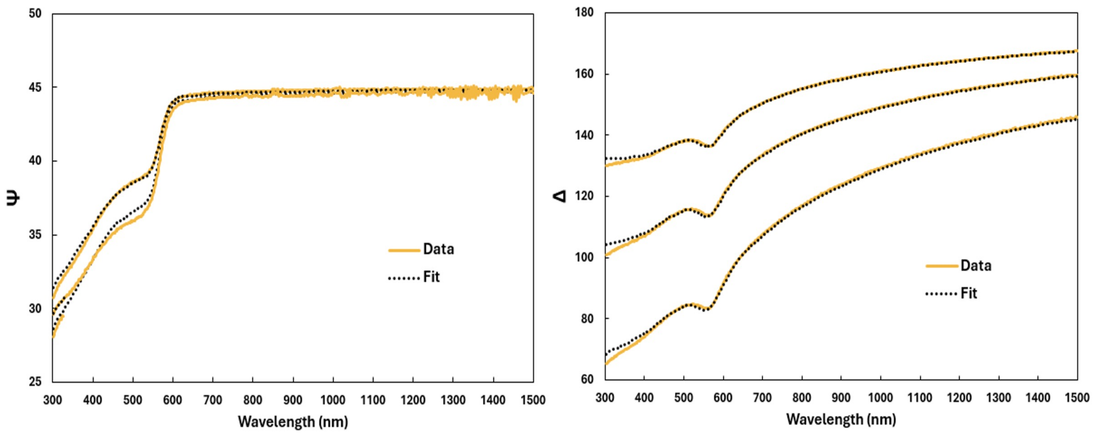

Figure 2: Developed spectroscopic ellipsometry model fit plots for FALEP copper sample.

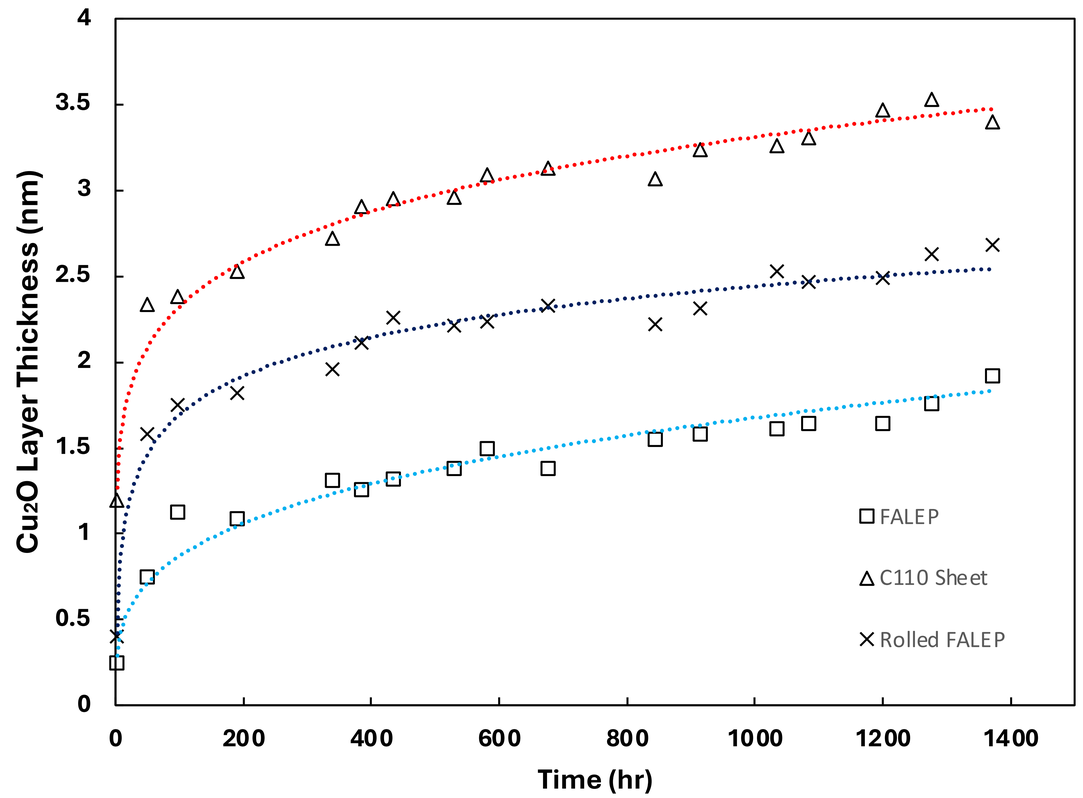

Figure 3: Plot of cuprous oxide layer thickness over time.

Discussion

Such analysis aims to quantify oxide layer thickness and delineate the growth kinetics of cuprous oxide under ambient conditions, providing crucial insights into the response of copper substrates to ambient environmental factors. Understanding surface oxidation dynamics is pivotal in evaluating the long-term antimicrobial efficacy of copper and optimizing its applications in combating infectious diseases.

Variation in oxide layer formation occurs due to differences in crystallographic orientation and texture. Copper has different surface energies in different orientations [3]. These orientations can be influenced through processing such as friction-assisted lateral extrusion process (FALEP).

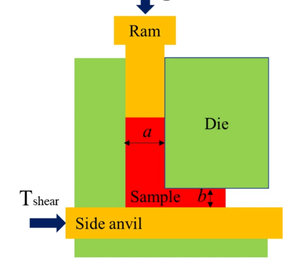

Figure 4: Diagram of FALEP process [4].

Future Work

Microhardness measurements to further characterize samples and oxidation dynamics.

Further studies could be performed at elevated temperatures to confirm the kinetics of these results.

Analysis including other oxide compounds: cupric oxide, etc.

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[2] J. Hilfiker and J. Woollam, "Ellipsometry." Elsevier, 2005.

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[4] Tóth, L.S., Sepsi, M., Szűcs, M. et al. The mechanics of the friction-assisted lateral extrusion process. J Mater Sci (2024). https://doi.org/10.1007/s10853-023-09245-1