CENTRO FEDERAL DE EDUCAÇÃO TECNOLÓGICA CELSO SUCKOW DA FONSECA
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COORDENADORIA DO PROGRAMA DE PÓS-GRADUAÇÃO EM INSTRUMENTAÇÃO E ÓPTICA APLICADA

A Coordenadoria do Programa de Pós-Graduação em Instrumentação e Óptica Aplicada tem a satisfação de convidá-lo para assistir à

**DEFESA DE TESE DE DOUTORADO**

TÍTULO:

# FUNCTIONAL TRANSITION METAL OXIDE ELECTROCATALYSTS FOR HYDROGEN AND OXYGEN EVOLUTION REACTIONS

**Jose Antônio Fontes de Carvalho Ribeiro Rodrigues**

Hydrogen production through water electrolysis represents a promising approach for the development of low-carbon energy systems, particularly when powered by electricity generated from renewable sources. However, the efficiency of this process depends on the development of electrocatalysts capable of reducing the overpotentials associated with the hydrogen evolution reaction (HER) and oxygen evolution reaction (OER). In this thesis, transition metal oxide-based electrocatalysts were investigated, focusing on nickel oxide (NiO), cobalt oxide (CoO), and copper-cobalt oxide (CCO). The prepared materials were characterized using structural, morphological, and electrochemical techniques to evaluate their catalytic activity in alkaline media. Electrode performance was investigated through linear sweep voltammetry, Tafel analysis, ECSA, electrochemical impedance spectroscopy, and stability measurements. Electrochemical measurements performed in 1M KOH demonstrated that the CCO electrode exhibited the best HER performance, achieving a current density of -10 mA/cm$^2$ at an overpotential magnitude of 250 mV, compared with 396 and 427 mV for CoO and NiO, respectively. For OER, CCO also exhibited the lowest overpotential, approximately 437 mV at 10 mA/cm$^2$, whereas CoO and NiO required 636 and 666 mV, respectively. Electrochemical analyses revealed differences in the apparent kinetic and interfacial behavior of the investigated materials. Stability measurements conducted over 14 hours provided additional information about their operational performance under alkaline medium. Overall, the results demonstrated that combining copper and cobalt in a mixed-metal oxide improved electrocatalytic performance under the investigated conditions, highlighting the potential of CCO for alkaline water electrolysis applications. This research was developed at the Laboratory of Experimental and Applied Physics (LaFEA), Federal Center for Technological Education Celso Suckow da Fonseca (CEFET/RJ), Brazil, contributing to the investigation of transition metal oxide electrocatalysts for electrochemical hydrogen production.

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