

# Electrochemical properties and coloring mechanism electrochromic Ru-modified $V_2O_5$ smart films: In situ X-ray spectroscopic study

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Vanadium pentoxide is of great interest to engineers and scientists owing to its multichromism. As is known, ruthenium-contained material exhibits high catalytic performance. In this work,  $V_2O_5$  and Ru-modified  $V_2O_5$  smart films were prepared by sol-gel based spin coating for the electrochromic application. The optical and electrochromic properties of these films were obtained by UV-Vis and cyclic voltammetry measurement. The electrochromic coloration and bleaching were made at different bias potentials. The  $V_2O_5$  doped with various doping concentrations of ruthenium dioxide exhibits a better redox characteristics than pristine  $V_2O_5$ . X-ray absorption spectroscopy was carried out for determination of atomic and electronic structures of pristine  $V_2O_5$  films and those modified with Ru. Furthermore, in situ x-ray absorption spectroscopy was performed to study how the atomic and electronic structure vary with different bias potentials, providing the crucial coloration and fading mechanism for these Ru-modified  $V_2O_5$  electrochromic films.