MISSOURI S&T

Chemistry Seminar

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4:00 pm in 303 Schrenk Hall

Epitaxial Growth of Metal-organic Framework Thin Films and Foils by Electrochemical Conversion

Abstract: Metal-organic frameworks (MOFs) are an important class of crystalline porous materials with extensive chemical and structural merits. However, the fabrication of MOF thin films oriented along all crystallographic axes to achieve well-aligned nanopores and nanochannels with uniform apertures remains a challenge. Copper(II)-benzene-1,3,5-tricarboxylate, $Cu_3(BTC)_2$ (referred to as Cu-BTC) is a well-known MOF material with a cubic crystal system. Epitaxial single-domain Cu-BTC(111) thin films were manufactured by electrochemical conversion of Cu_2O(111) films electrodeposited on single-crystal Au(111). The Cu-BTC(111) shows an in-plane antiparallel relationship with the precursor Cu_2O(111) with a -0.91% coincidence site lattice (CSL) mismatch. A plausible mechanism was proposed for the electrochemical conversion of Cu_2O to Cu-BTC, indicating formation of intermediate CuO, growth of Cu-BTC islands, and termination with coalescence into a dense film with a limiting thickness of about 740 nm. The Faradaic efficiency for the electrochemical conversion was 63%. In addition, epitaxial Cu-BTC(111) foils were fabricated by epitaxial lift-off following the electrochemical etching of residual Cu_2O underneath the Cu-BTC. It was also demonstrated that Cu-BTC(111) films with two in-plane domains and textured Cu-BTC(111) films can be achieved on a large scale using electrodeposited Au/Si and Au-coated glass as low-cost substrates. Also, the methods of electrodeposition and chemical bath deposition have been explored to produce epitaxial MOF thin films.