

## Description of Additional Supplementary Files

**File name:** Supplementary Movie 1

**Description:** In-situ monitoring of the F-Cu crystallization process under an optical microscope.

**File name:** Supplementary Movie 2

**Description:** In-situ optical microscopy observation of phenylalanine-coordinated Copper ions (F-Cu) crystallization kinetics.

**File name:** Supplementary Movie 3

**Description:** In-situ reaction monitoring of 2,4-DP and 4-AP catalyzed by F-Cu crystals.

**File name:** Supplementary Movie 4

**Description:** Real-time monitoring of 2,4-DP and 4-AP oxidation in the presence and absence of the F-Cu catalyst.