Antibacterial γ-CD-MOF Complex Functionalized Film for Fish Meat Safety and Freshness

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Synthesis of γ-CD-MOF and its complex

γ-CD (2962 mg) and KOH (1024 mg) were dissolved in 80 mL ultra-pure water, stirred thoroughly at room temperature, and filtered through a 0.45 μm membrane. The filtrate was mixed with 48 mL MeOH in a conical flask to form a white solution, which was then stirred in a 90°C water bath (400 rpm) for 5 minutes. After adding polyethylene glycol 8000 (1024 mg) and stirring for another 5 minutes, the flask was transferred to a cold-water bath and left overnight to precipitate. The white precipitate was centrifuged (5000 rpm, 5 minutes), washed thrice with MeOH, dispersed in MeOH, and vacuum-dried at 60°C for 5 hours to yield γ-CD-MOF. For the γ-CD-MOF complex, 46.5 mg γ-CD-MOF was immersed in 5 mL acetonitrile containing 1.25 mM chloroauric acid. The suspension was gently shaken (60 rpm) and incubated at 37°C in the dark for 21 hours. The resulting γ-CD-MOF complex was collected by centrifugation (5000 rpm, 5 minutes), washed repeatedly with acetonitrile, and vacuum-dried at 60°C for 5 hours.

Synthesis of functionalized film

8 g Polydimethylsiloxane SYLGARD elastomer and 0.8 g curing agent were dissolved in 40

mL n-hexane, stirred at 1000 rpm for 30 minutes, cast onto a polytetrafluoroethylene substrate, evaporated at room temperature for 5 hours, and thermally treated at 80°C for 15 minutes. Meanwhile, 150 mg γ-CD-MOF complex was dispersed in 20 mL n-hexane, poured onto the pre-cured membrane, and after n-hexane evaporation (5 minutes), cured at 70°C for 5 hours. A pure film was fabricated identically without γ-CD-MOF complex.

Cytotoxicity assay of γ-CD-MOF complex

Caco-2 cells were cultured in DMEM (10% fetal bovine serum). γ-CD-MOF complex was dissolved in DMEM at 1000, 500, 250, 125, 62.5 μg/mL. 10 μL of each solution was added to wells, incubated at 37°C for 48 hours, then 10 μL 1× CCK8 was added and incubated 2 hours more. OD_{450} was measured via microplate reader; cell viability (A%) was calculated as follows:

$$A(\%)=(As/Ac)\times 100\%$$

As and Ac represent the absorbance of the experimental group and the control group, respectively. Each sample was triplicated.

Gold ions loading rate

The loading capacity of gold ions in the γ-CD-MOF complex was quantified via the following protocol: initially, 10 mg of γ-CD-MOF complex was dispersed in 1 mL of deionized water to form a homogeneous suspension. The resulting suspension was subjected to acid digestion, followed by a 1000-fold dilution with 1.5 M hydrochloric acid. The gold ions concentration in the diluted solution was determined using an inductively coupled plasma mass spectrometer (ICP-MS, Nexions 300XX, PerknElmer, USA). The loading capacity of gold ions was computed based on the following formula:

$$L(\%)=C_{Au}/(C-C_{Au})\times 100\%$$

where L was the percentage loading rate (%), C_{Au} was the content (mg) of gold ions, and C was the content (mg) of total γ-CD-MOF.complex.

Water vapor transmission rate analysis

The water vapor transmission rate (WVTR) of pure film and functionalized film was determined via the gravimetric method using a water vapor transmission rate analyzer.

Specifically, the films were cut into circular discs with a diameter of 74 mm, and the tests were conducted under controlled conditions of 38℃ and 90% relative humidity.

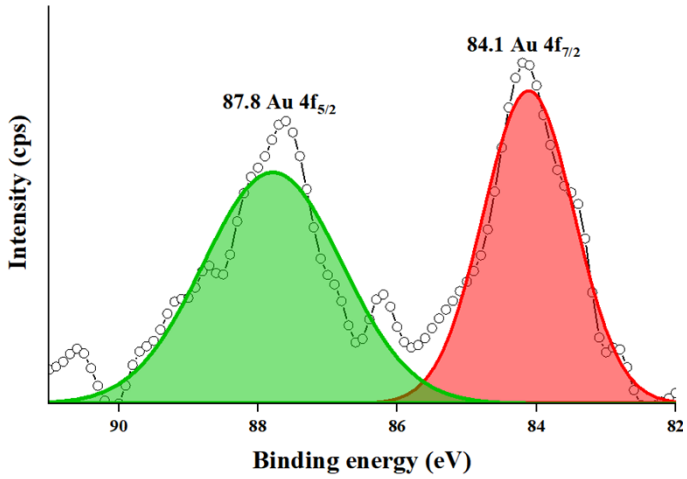

Fig. S1. High-resolution Au 4f XPS spectra obtained from γ-CD-MOF complex.

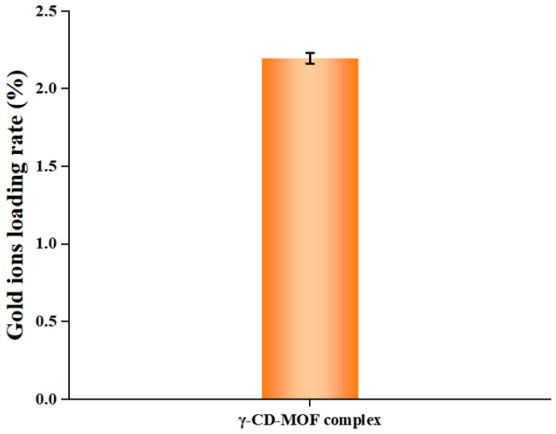

Fig. S2. Gold ions loading rate of γ-CD-MOF complex.

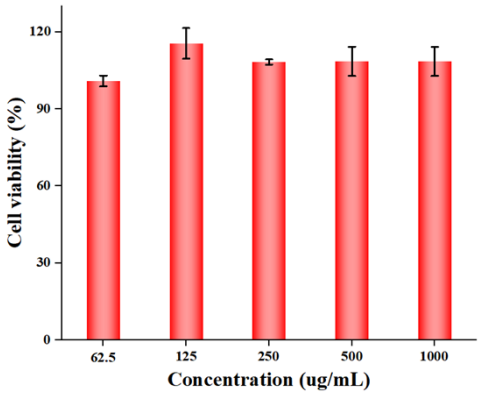

Fig. S3. In vitro cell viability of Caco-2 cells against γ-CD-MOF complex.

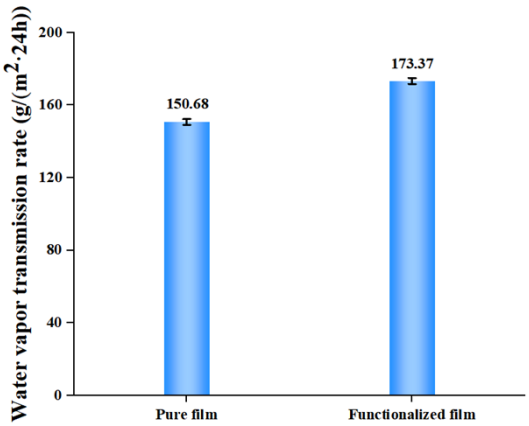

Fig. S4. Water vapor transmittance rate of pure film and functionalized film.

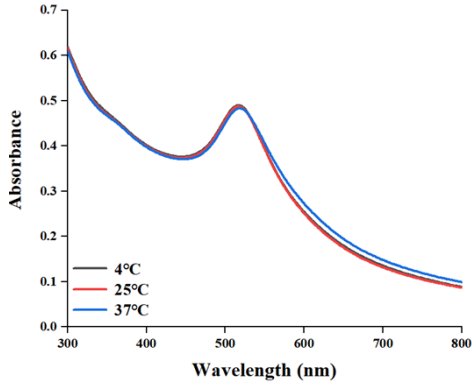

Fig. S5. UV-Vis absorbance spectra of γ-CD-MOF complex storage at different temperatures for 7 days.