Monitoring Drug Loading and Releasing in MIL-88B(Fe) Films on Modified Gold Substrates using Surface Plasmon Methods

CALIFORNIA STATE UNIVERSITY **LONG BEACH**

Trenton Nguyen, Hao Pham and Dr. Fangyuan Tian
Department of Biomedical Engineering and Department of Chemistry

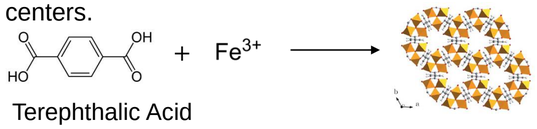
ABSTRACT

Coronary Artery disease (CAD) is a major leading cause of death in the United States. Characterized by plaque narrowing the blood vessel, people with CAD have a higher chance of experiencing heart attack and stroke. Our research studies the effects of using MIL-88B, a porous structure of the class: Metal Organic Framework (MOF) as a porous inorganic coating on drug eluting stent (DES), to prevent CAD and minimize restenosis and thrombosis effects. MIL-88B was synthesized under a solvo-thermo method and used for UV-Vis to see drug delivery properties while implementation of MIL-88B on gold was used as a model to see the binding of Ibuprofen on MIL-88B as well as the binding of 16-Mercaptohexadecanoic acid (MHDA) on gold for SPR experiments. Our results confirmed the successful preparation of ibuprofen loaded MIL-88B film on MHDA functionalized gold substrate.

METHODS

Synthesis:

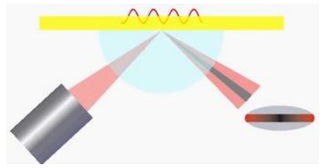
MIL-88B is synthesized by mixing a set amount of metal, Iron (III) Chloride with ligand, Terephthalic acid in DMF solvent. After heating for about 12 hours, a network of metal framework developed with porous centers.



Terephthalic Acid

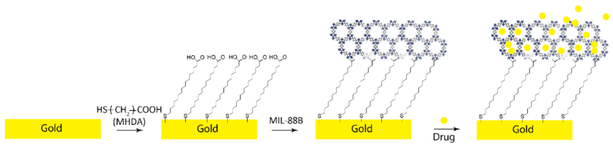
Surface Plasmon Resonance (SPR)

SPR allows real-time, label free detection of biomolecular interactions.



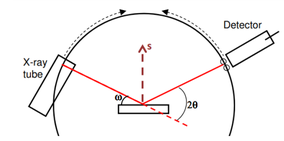
Self Assembled Monolayer (SAM):

The formation of MHDA SAM on clean gold surface was monitored using SPR. Similarly, the binding of MIL-88B to MHDA along with ibuprofen loading was studied using SPR.

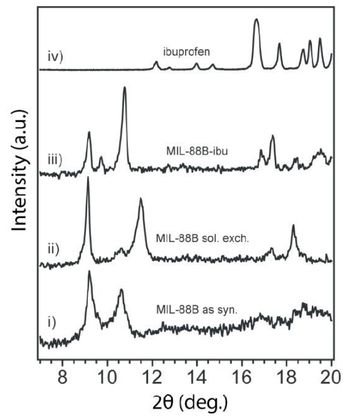


RESULTS

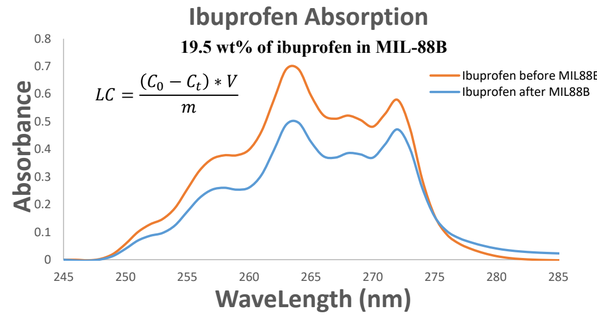
X-ray Powder Diffraction (XRD)

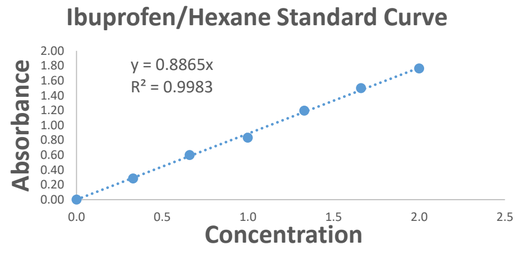


PXRD patterns of MIL-88B at the condition of
i) as-synthesized,
ii) after solvent exchange
iii) after loading with ibuprofen, in comparison to the PXRD patterns of
iv) pure ibuprofen.



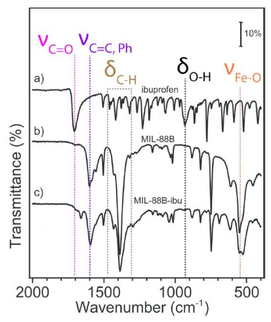
UV-Vis Spectroscopy



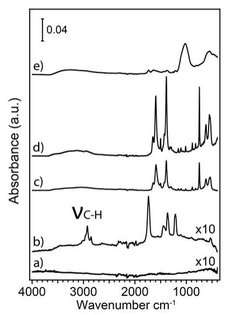


Infrared Spectroscopy

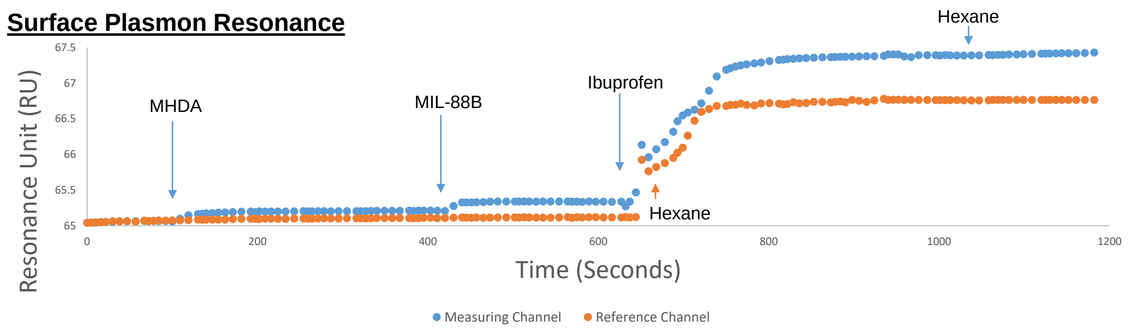
ATR-IR spectra of
a) pure ibuprofen,
b) pristine Fe-MIL-88B,
c) ibuprofen loaded Fe-MIL-88B



FTIR spectra of
a) Au surface,
b) MHDA SAM modified Au surface,
c) Fe-MIL-88B thin film on a MHDA-functionalized Au substrate,
d) ibuprofen loaded Fe-MIL-88B thin film
e) Fe-MIL-88B thin film after drug releasing.

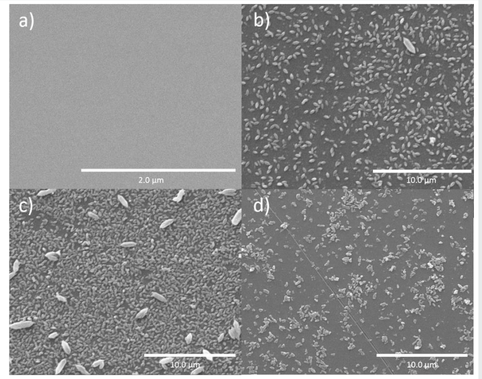


Surface Plasmon Resonance



Scanning Electron Microscopy (SEM)

SEM images of
a) clean gold
b) MIL-88B crystals on MHDA-modified Au surface
c) ibuprofen loaded MIL-88B crystals
d) MIL-88B after releasing ibuprofen in PBS.



CONCLUSION

We confirmed the encapsulation of ibuprofen within the porous MIL-88B structures by optical spectroscopic studies. The drug loading capacity of the testing Fe-MIL material was found to be about 19.5 wt% for ibuprofen delivery. SPR results showed successful binding of a MHDA SAM on clean gold surface within a few minutes. Additionally, we prepared a uniform MIL-88B film on a MHDA modified Au surface via covalent bonding. The successful encapsulation of ibuprofen in MIL-88B was confirmed by a significant change in SPR resonance response in the *in situ* studies. Following hexane wash, no significant decrease in SPR signal was observed for the ibuprofen-loaded MIL-88B film. This confirmed ibuprofen was encapsulated inside of MIL-88B cages not being adsorbed on the outer surface.

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