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# Radiation assisted energy conversion using metal-organic ligand network

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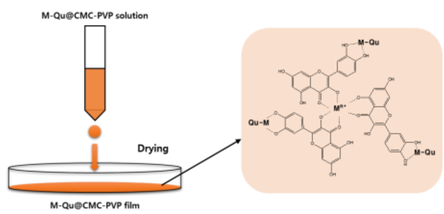
## 1. Introduction

To apply the energy conversion effect to the research on radiation-resistant material development [1], a metal-organic network based material was developed by combining high-Z elements such as Hf, Ta, and Eu. Organic ligand possesses a conjugated chemical structure that allows it to function as an electron donor and acceptor, enabling electron delocalization [2]. The high-Z element based metal-organic ligand network effectively can convert radiation energy through metal-to-ligand charge transfer. To demonstrate radiation energy variation, we utilized polymer complex composited with carboxymethyl cellulose (CMC) and poly vinylpyrollidone (PVP) as a matrix, which is eco-friendly materials and easy to prepare for film with metal-organic ligand network by the simple mixing. Irradiation of UV light and X-ray on the metal-quercetin contained CMC-PVP film were conducted to confirm energy down conversion effect and stability from high-energy radiation.

## 2. Method and Results

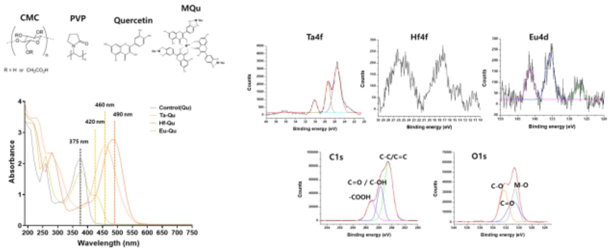
### 2.1 Preparation of metal-organic ligand network

For synthesis of metal-organic ligand network [3], we determined that ratio of metal and organic ligand is 5:1. The precursor solution were simply vortexed and stirred for 1 hour. Color of the mixed solution was changed by metal ion coordination. 5% of CMC solution and 2% of PVP solution were prepared in distilled water. After that, CMC and PVP solution were completely mixed. The Metal-organic ligand network solution was added in CMC-PVP mixed solution and vigorously stirred for 1 min and poured in petri-dish and dried at room temperature. The film was completely dried using vacuum oven for 2 days.



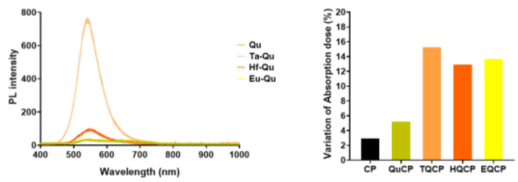

### 2.2 Chemical structure and optical properties of the film

The chemical structure and optical properties were characterized by measurements of UV-Vis spectrometer, X-ray photoelectron spectroscopy (XPS). As a result, we confirmed that metal ions were coordinated with organic ligand through catechol groups or hydroxyl and ketone groups. CMC-PVP was homogeneously formed through physical bonding mechanisms.




### 2.3 Effect of energy conversion

Through photoluminescence measurements of metal types (Ta, Hf, Eu) bound to organic ligand, the energy conversion characteristics of the UV region can be confirmed. The PL peaks of all samples occurred at 550 nm with an excitation energy of 325 nm. However, the intensity of the PL peaks in the organic ligand (Qu) and Eu–Qu samples was very low. Qu determined the PL emission wavelength, but the intensity varied depending on the metal element bound. X-ray energy was generated at a voltage of 320 kV, and a current of 5 mA in the inspection device, and the film and Fricke solution samples were examined for 1 h. The results showed a change rate of 15.38%, 13.07%, and 13.83% upper than that of the control. The possibility of X-ray energy conversion by the metal-organic ligand network generated by the co-placement of high-Z or lanthanide metal elements and Qu was confirmed through an actual analysis of the X-ray energy absorption dose change rate.




## 3. Conclusions

We synthesized the metal-organic ligand network as an energy conversion material through a very simple synthesis method, and confirmed chemical structural analysis and optical properties and their energy conversion efficiency. This material could be used as a high-quality energy conversion material for broadband radiation energy, and as a highly stable material.

## REFERENCES

[1] K.D. Oskam, R.T. Wegh, H. Donker, E.V.D. van Loef, A. Meijerink, Downconversion: a new route to visible quantum cutting, Journal of Alloys and Compounds, Vol. 300-301, No. 12, pp. 421-425, 2000.
[2] H.A. Nasar, F.H. Hanoon, Quercetin-based donor-π-acceptor organic dyes for a dye-sensitized solar cell: A DFT and TD-DFT study, AIP Conference Proceedings 2292:030006, 2020.
[3] X. Chen, K. Li, Z. Yuan, Y. Zhou, J. Xu, L. An, J. Hu, Y. Liu, Metal–Phenolic Networks as a Universal Aqueous Dispersing and Immobilizing Agent for Nanocarbon Materials: A Facile Strategy for Synthesis of Electronic and Energy Materials in the Aqueous Phase, ACS Appl. Electron. Mater, Vol. 4, No. 12, pp 6149-6156, 2022.