Metal Organic Frameworks: Forming Nano-Compounds and Photonic Interfaces

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Abstract—We consider the different porous crystalline compounds forming 1, 2, or 3-dimensional structures that can use metal ions and their interchange with the organic molecules determining the electronic interface from the electronic information level in the hybrid transition zone that is a photonic interface between organic-metal linker called a linking.

Keywords — Nano-compounds, Organic-metal linking, photonic interface, porous crystalline structure;

I. INTRODUCTION

The metal organic framework were born from zeolites, and porous crystalline structures study and both found in nature or man made. For one side, the zeolites are made from aluminosilicate materials. For other side, the porous crystalline structures (Figure 1) are observed boiling out of the some rocks.

The zeolites in the Chem-E-industry are used as catalyst and adsorbant. The MOF’s (Metal Organic Frameworks) are the following generation which has been synthesized in two ways:

- solvothermal techniques, crystals are grown from a hot solution of metal precursor, such as a metal nitrate solution
- mechanical-chemical methods, grinding, to produce, however these are none porous
- mechanochemical methods with the addition of isonicotinate (ISA) created porous 3D crystals

One property of our interests is as solid structures produced by mechanic-chemical synthesis; MOF’s have very unique electrical properties being explored, which consist in replace liquid crystals for optoelectronic applications through of some molecular nano-techniques, for example:

- Rotating or twisting molecules under an electric field is the principle behind liquid crystals. MOF crystals could lead to sturdier materials to be used in the data communications industry
- Currently tested MOF’s do not yet reach the barrier to rotation to replace liquid crystals

These defines some interface materials in micro-electronic compounds and nanotechnology as catalyst paper, amino-acid-based-metal-organic-nanofibers, special polymers nano-fibers, thin films, quasi-crystals, optical filters, mirrors and anti-reflection coatings.

Fig. 1. Image by HTVM, of zeolite crystals.

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Fig. 2. a). First discrete metal-organic nanotubes by layer-by-layer growth. Creation of coordination polymer based gels and nanofibers. b). Created Gd(III) based nanorods used as contrast agents by water-in-oil microemulsion based technique. Both structures are efficient in light harvesting due to $D_1$ structure.

We want design and develop photo-sensible materials that realize a photonic interchange with other chemical systems which need photon information to captured or transfer electrons or micro-charges as multiple of electrons. 
There is development in electronic devices with MOFs that can manage micro-electronic currents and establish an electronic current with MOF’s as sources using perhaps some materials as the Figure 2 and 3.

**Fig. 3.** Long chiral nano-fibers can be grown using traditional coordination chemistry and biologically derived components by utilizing diffusion controlled growth procedures.

The electronic devices obtained by this MOFs have many electrical properties derived from these nano-fibers and their interaction with thin films of semi-conductors or conductor metals that can

**Fig. 4.** Potential functions of MOF’s within electronic and micro-electromechanical systems (MEMS): a) Electronic (active), b) electronic (passive), c) nano-crystal structure, d) Scaffolding with nanofibers of type showed as the before figure [1].

The photonic MOF, are photonic crystals as hyper-sensible under a physical property where their sensing approach is based on the utilization of the photonic crystal sensing (PCS) as tunable optical fibers capable of dynamically changing their refractive properties when in contact with an analysis of interest, or when exposed to external stimulation such as temperature, irradiation, or electrical and magnetic field stimulation on through micro-charges or magnetic fluxes. For the periodicity of the lattice of the multilayer structure, this creates a periodic potential to photons in one dimension obtaining a photon spectra with particular energies, called the photonic stop band. The position of the stop band can be modulated by varying the optical thickness (the product of refractive index and physical thickness) of the layers in response to an external stimulus.

Our research will focused in the phonic properties as the described using certain combinations in the creation of the nano-compounds (nanofibers, crystalline structures, quasi-crystals and more) that have these properties and their description as transfer or sources of photons in nature form.

**Fig. 5.** a) Three be-layer stack of the titanium dioxide layers with the average thickness 45nm. b) Bose-Einstein distribution to a photonic MOF compound.

Other novel 1 – dimensional photonic architecture based on a metal-organic framework (MOF) is TiO$_2$ nanoparticles (see Figure ) which is used to translate molecular absorption into an optical response [2]. Additional functionality is imparted to the system by combining textural mesoporosity arising from the nanoparticle based layers with inherent microporosity provided by the ZIF-8, was chosen, which is expected to contribute to enhanced size in a chemolectivity of the 1D MOF PC [3].

II. PRINCIPLES OF NANOTECHNOLOGY AND PHOTONIC TOPOLOGIES OF NANO-FIBERS AND CRYSTALS MOF

As was mentioned, the electronic interfaces of nanotechnological MOF compounds obey to topologies of nano-fibers and crystals formed by molecular arranges determined by organized transformations [4], and under the following nanotechnology principles

**Principle 1.** All MOF is an electronic-photonic interface in photonics.

**Principle 2.** All MOF is a topological hybrid $X \cup_Y Y$, with $X$ – metal and $Y$ – organic whose flow of energy is a Poincaré flow [5].

We consider the following axioms based in the division of study of MOF’s mentioned in the introduction:

a) If $X$, is hyper-cubic then is a zeolite,

b) If $X$, is organic then any continuous transformation $I$, satisfies:

$$I(X \otimes Y) = LX \otimes Y = X \otimes I(Y),$$
that is to say, the transformation of the MOF is obtained only of one side of the interface.

![Diagram of MOF and zeolite crystals](image)

**Fig. 6.** a) MOF Thin film. b) Cubic zeolite crystals. The increasing is realized through the superposing of cubic zeolite crystals (see Figure 1). The crystal showed is only 1-dimensional increasing, that is to say, in only one direction. To obtain the crystal configuration of the crystals showed in the Figure 1, must be considered MOFs in 2 and 3-dimensional structures. c) Nano-fibers.

An application in bio-technology is the addition of exceptional properties of semi-conductors to organic materials that have the function of regular the micro-charges in living organisms. Likewise, the final structure that requires an interchange of photons to the translation of a micro-charge not depends of the photon source in itself, but of the transition of these little compounds in MOF that translate said charge through of a correct emission of photons. For example, consider the molecular arrangement given of a MOF considered in the Figure 5.

### III. MICRO-ELECTROMAGNETISM TO MFO’S PARTICLES

The micro-charges given by little units of electrons have a realization of electrical and magnetic current in terms of the movement of these charges as [6]:

\[
J_{\mu}^a(x) = \sum_a e_a \int_{-\infty}^{\infty} ds \, \frac{dx_{\mu}^a}{ds} \delta(x(s) - x_a(s)), \quad (2)
\]

and

\[
*J_{\mu}^a(x) = \sum_a *e_a \int_{-\infty}^{\infty} ds \, \frac{dx_{\mu}^a}{ds} \delta(x(s) - x_a(s)), \quad (3)
\]

to one particle \(a\), where the notation \(*e_a\) is used to emphasize the symmetry between the magnetic and electrical quantities.

Considering the principle 2, mentioned in the before section II, the net change of \(W\) (where \(W_{ph}\), is photon source and the change of \(W\), is the change given in the metal-organic interface given by the corresponding photonic MOF) completing the circuit

\[
\begin{bmatrix}
\Delta W = \sum_a \frac{1}{2} \left[ \int_{\sigma_a(\Delta)} + \int_{\sigma_a(-\Delta)} \right] d\sigma (e_a *J_{\mu}^a - *e_a J_{\mu}^a) \quad (5)
\end{bmatrix}
\]

where \(\sigma_a(\pm \lambda)\), indicates the 3-dimensional volume associated with the particle, which is subject to the space of alternative displacement \(\pm \lambda^\mu\), for example, in the layers between semi-conductor plates.

The before integrals record the amounts of electric and magnetic charge within the various volumes (crystal formations, for example the zeolites).

### IV. SPECTRA AND MULTI-PHOTONIC PROOF

The creation of 1-dimensional infinite coordination polymer particles (ICP’s) via conventional coordination chemistry also, ICP’s offer

- Promising functionalities:
  - Magnetism
  - Porosity
  - Ion exchange
  - Optical properties
and encapsulating matrices of electric ions to strengthen the electronic links of other materials, for example, organic fabrics.

But to the electro-dynamical generating of micro-charges propitious to the photonic creation is necessary combine with the metal compounds that have a base of sequential spin-coating suspensions of nano-particles on glass substrates for example the homogeneous compound SiO$_2$/TiO$_2$ [2].

Then the ions interchange is carried out from the boundary of the crystalline structure generating a distribution of photons very uniform and coupled to the structure of TiO$_2$ (see the Figure 8 and Figure 9 b)) in the superior part that can see it in the Figure 8, with links of oxygen in red. The encapsulating matrix realizes the same function as the zeolites. This crystalline topology as was mentioned in the before section consider the cubic fine structure as the propitious to the generating of photons from the encapsulating of micro-charges with promising functionalities mentioned in their MOF structure.

Then we can enunciate:

**Proposition V. 1.** Consider the arrangement of nanofibers defined by (one scaffolding) CP $\times$ CP $\times$ CP $\times$ CP, in the conformally of the MOF’s region of the space-time where is satisfies to a 3-dimensional structure (3-dimensional surface)

$$(e_a \ast e_b - e_a \ast e_b) \frac{1}{2} \left[ \int_{\sigma(\lambda)} + \int_{\sigma(-\lambda)} \right] d\sigma \mu f^\mu(x) = 2\pi n,$$

(8)

$\forall n \in Z^+$, the particles $a$, and $b$, are displaced to out of the crystalline compounds of the MOF as cycles in every layer. These cycles correspond to photonic field integrals as given in (2) and (3) belonging to the cohomology $HH^*(D_0^c (\text{tot}(\text{CP}_3 (3))))$. [7]

That be a cohomology as has been mentioned means that these set of integrals includes all the deformation field of every face of crystalline compounds of the cubic 3-dimensional and have simple phenomena on every side. Here the set of objects stands for category with support at the zero sections, that is to say, Pfaffian cubics (as given in (6)) are obtained from CP (see the Figure 10).
Fig. 10. a) Cubic $3^-$ dimensional crystalline compounds and their alignment of nana-fibers. b) MOFs as dielectric waveguides to fiber optic lines. The cycles are given by the simple $1, 2$ and $3^-$ dimensional photonic crystals (with corresponding scaffoldings).

A new technique to create patterns in unique crystals as given in the 3-dimensional crystalline compounds to photonic structures is through of hydrogel nano-particles. In this case the photon distribution obeys to the pattern given in the Figure 5.

VI. CONCLUSIONS

The development of new technologies with more interactive grade and functionality require of the creation of technologies on the MOFs under a study on properties of TQT (topological quantum theory) using the crystallographic field theory and crystalline compounds properties studied in micro-electronics, nano-materials and photonic materials on the context of the non-canonical field theory to obtain an functional architecture of these materials under the principle 1, established to guide the photons inside/outside of these materials. Of this way, the prospective of the development of new MOFs, based in mixture context of the organic-metal can be established to realize easy manageable organized transformations under a simple geometry, aligning the corresponding compounds as nano-fibers and crystalline compounds in the understudied that these disposal geometries are images that obeys a homological relation with the crystallographic image of the space-time in each case and to quantum interaction used.

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References