

5. Summary and concluding remarks

A high-performance hydrogen gas sensor has been developed that utilizes a proton affinity of DPPP on the basis of the crystal and electronic structure. The conclusions drawn from the present study can be summarized as follows.

1. The sensor exhibits a remarkable reduction of electrical resistivity by two orders of magnitude even under 0.05 % H₂.
2. The device operates at room temperature and is reversible.
3. No noticeable effect of ambient gases (such as CH₄, CO, CO₂, NO, SO₂ and water moisture) on the sensor performance is recognized.
4. The charge carriers are determined to be electrons.
5. Phase I of the polymorph is found to be the right phase for H₂ gas sensors.
6. The sensor device should be driven with AC in the frequency region between 10 and 500 Hz.

As described in the present thesis, most of the work on the H₂ gas sensor based on DPPP has been completed, although the structure of *meta*-DPPP is not yet determined. Our next target is to extend the present successful results to other pigment classes in order to achieve an even better performance. Our basic concept is to directly integrate pyridyl rings into the chromophore of organic pigments. Some phthalocyanine and perylene derivatives as shown in Fig. 1 are now under investigation. In Cu-phthalocyanine, four phenyl rings at the periphery have been replaced by four pyridyl rings which surround the chromophoric macrocycle composed of 18 π electrons. Similarly, in perylene imide derivatives, two pyridyl rings are directly connected to the perylene imide skeleton which acts as the chromophore. These derivatives exhibit a

higher sensitivity than DPPP by, at least, one order of magnitude. In addition, these are more light- and heat-stable than DPPP and less expensive. Further investigation on other pigment classes are also in progress. Our ultimate goal is to supply our society with reliable, inexpensive and compact H₂ gas sensors for the fuel cell which is expected as a clean energy source for the future.

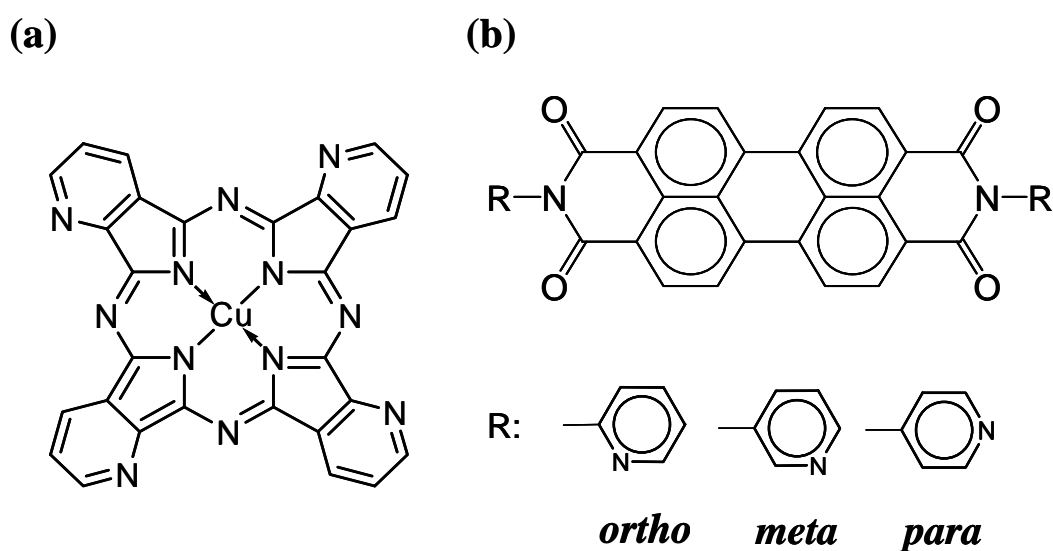


Fig.1 Pyridyl derivatives: (a) pyridyl Cu-phthalocyanine and (b) pyridyl perylene-imide derivatives