MASTER'S THESIS

Synthesis, characterization and application studies of ionic platinum(II) complexes

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Abstract

This thesis is dedicated to developing novel charged Pt(II) complexes and exploring their applications in electroluminescence, bio-imaging and the preparation of soft salts.

At the beginning, a brief introduction about the development of ionic transition metal complexes and an overview of their applications in electroluminescence, bio-imaging and soft salts are presented.

In chapter 2, a series of anionic Pt(II) complexes were successfully synthesized and fully characterized for their application in electroluminescence with relatively small current density. All the complexes show highly intense emission from blue to red in the solid state but is almost non-emissive in solution. The obtained single crystal data show that the anionic Pt(II) complexes exhibit very large Pt-Pt separation of over 10 Å in the crystal packings due to the bulky counterion $[N(n\text{-}C_4H_9)_4]^+$. The strong interactions between adjacent $[Pt(C\hat{}N)(CN)_2]^-$ is thus absent in the solid state and this is considered as the main reason for the different properties in solution and solid state of these anionic complexes. This kind of Pt(II) anionic complexes has also found application in electroluminescence with relatively small current density.

A series of novel water-soluble cationic Pt(II) complexes have also been designed and synthesized in chapter 3. Their photophysical properties in both water solution and solid state were investigated. Some of the cationic Pt(II) complexes have been selected to be applied in cell imaging in both live human hepatoma cells (BEL-7402) and mouse embryonic fibroblast (MEF) cells. The results show that these complexes have a much higher cellular uptake in BEL-7402 cells (tumor cells) than in MEF cells (normal cells), indicating these complexes are promising probes for tumor cell imaging.

All of the cationic Pt(II) complexes show very low cytotoxicity at low concentration and the cell viability is still assessed to be high even when the concentration increases to 150 μM. The localization of the complexes turned out to be in the cytoplasm and accumulate near the cell nucleus.

Attempts have been made to obtain efficient deep-red or NIR Pt(II) complexes by taking advantages of the Pt-Pt interactions in chapter 4. Two Pt(II) soft salts, **SS1** and **SS2** with bright emission at 674 and 718 nm, have been successfully prepared and characterized. The crystal packing shows a short separation between the two Pt atoms of 3.476 Å and the average distance of two planes of the cyclometalated ligands is 3.360 Å, indicating the existence of strong intramolecular Pt-Pt and π-π interactions. It is the first examples of Pt(II) soft salts bearing strong Pt-Pt interactions and π-π stacking and this has opened a versatile and facile avenue to prepare efficient NIR Pt(II) emitters by taking advantages of the Pt-Pt interactions. **SS2** shows different emission in PEG with different concentration and excitation wavelength, indicating their potential application in optical data storage. The electrochromic properties of **SS2** have also been investigated considering that the soft salt consists of ions with opposite charges, which suggests the soft salt could be promising candidate for electrochromic and optoelectronic material. The Pt(II) soft salt has also been used as NIR in-vivo imaging probe.

Chapters 5 presents the concluding remarks and points out some further work that could be done in the future. The experimental details are displayed in Chapter 6.

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