CHAPTER 6

CONCLUSION
6.1 Conclusion

The aim of the present investigation is to incorporate organic molecules into inorganic oxide glasses to find potential optical, catalytic applications of such hybrid materials. The following are the conclusions that could derive from my work.

1. A successful synthetic methodology was designed to introduce organic molecules into borate and Lead-tin-fluoro phosphate (LTFP) glasses without any damage to organic molecules. I also showed how the methodology could be modified to increase moisture resistance for such hybrid materials.

2. meso, β-substituted freebase Porphyrins and metalloporphyrins (M=Al(III) and Sn(IV)) were selected for preparation of hybrid materials. Porphyrins were chosen for its exciting and diverse electronic, electrochemical and catalytic properties.

3. The powder XRD and SEM results reveal that the hybrid materials were found to be homogeneous confirming that porphyrins have embedded into the glass matrix through covalent bonds. Lead-tin-fluoro phosphate (LTFP) glasses produced only tin porphyrins.

4. The electronic absorption, fluorescence emission properties indicate extensive modifications to porphyrin structure. The structural modifications arise from boron coordination with porphyrin core and peripheral functional groups. The new porphyrin structures inside glass matrix showed new electronic properties
that could be exploited as new optical materials especially as nonlinear optical materials and band pass optical filters.

5. Analysis of various spectral evidences allowed me to speculate possible structures of porphyrins inside glass matrix.

6. The structural modifications of porphyrins with various Lewis acids were performed to have more insight the nature of bonding in glass matrix. It was found that all Lewis acids coordinate strongly with porphyrin pyrrole nitrogens to form 1:1 or 1:2 stoichiometric complexes. In particular, BF$_3$ shows varieties of coordination possibilities especially in presence of appropriate peripheral functional groups in the porphyrin.

7. The behaviour of H$_2$TPPS$_4$ porphyrin is different from that of other porphyrins. New type of BF$_2$ mediated aggregates have been found with H$_2$TPPS$_4$ in presence of BF$_3$. These aggregates are of J-type and can be a potential candidate for solar energy harvesting activities.

8. The basic nature of the freebase porphyrins was exploited to be used as HCl gas sensor. The porphyrins immobilized in silica thin film showed excellent response to HCl gas concentration and quantitative measurement of HCl in gases form was monitored through colour changes. I have designed a new sensor setup that can detect HCl gas concentration down to 0.01 ppm level.

9. No interference was found due to other well known other industrial gaseous emission like SO$_2$, CO$_2$, NO, CO and Cl$_2$.

10. My theme of bringing about new application avenues from porphyrins in new environment is successful.
6.2 Future directions

During our course of work, we have come across numerous unexplainable experimental results. All these results, however, indicate towards formation of new, hitherto unknown, structural species of porphyrins under different conditions. For example,

1. Variety of functional materials can be prepared by choosing different conjugated organic chromophores into different host networks.
2. Lewis acid adducts of hydroxy substituted porphyrin in strongly nonpolar solvents have shown promising results that could be exploited as solar energy converters.
3. Materials prepared with graphene oxide and porphyrins have shown interesting results towards application as nonlinear optical materials. In fact one of our preliminary investigation showed unexpectedly high nonlinear absorption properties that are being watched by researchers worldwide.\textsuperscript{114}
4. New kind of hydrogel environments have shown to bring about new electronic behaviour in organic molecules.
5. Our low cost HCl gas sensor results showed promises and new direction towards designing newer chemical based gas sensors, and investigations are under progress towards sensing volatile toxic organic vapours both qualitatively and quantitatively.