# Chapter 6

## “Conclusion and Future Scope”

## 6.1 Conclusion

Overall, perovskite-based materials have been utilized throughout my thesis works, where the majority of the studies were developing sensing methods and another goal was finding the photocatalytic properties. Starting from solar cells to sensor fabrications, perovskite materials play a vital role in the current trends of material chemistry. However, the degradation in humid conditions is the main drawback of halide-based perovskite chemistry. To overcome this drawback, encapsulating method of the perovskite crystal lattice with hydrophobic ligands prevents the lattice structure from degradation and is also able to increase its photoluminescence quantum yield.

Sensing methods with perovskite materials to detect the analytes including metal ions, and biomolecules are the heart of the thesis. The high-intensity peak of the luminescence peak of metal halide based perovskites makes them act as an efficient candidate to act as a sensor. In general, the luminescence peak enhancement or quenching towards different analytes happens due to various mechanisms such as photoinduced electron transfer (PET), Förster resonance energy transfer (FRET), dynamic quenching mechanism, etc. The high luminescence quantum yield and narrow full-width half maxima are the two major boosting factors to act halide-based perovskites as a sensor probe with a lower detection limit.

Defect chemistry of the perovskite crystal lattice is the sole concept in the last chapter. Based on their vacancies, defects are classified as substitutions, dislocations, etc., and based on their formation, the defects can be categorized as point defects, bulk defects, planar defects, etc. The defects can create an energy level in between the original energy orbital of the lattice. Thereby, defects provide a new short-hand pathway to carry the charge carriers to the original structure. Thus, it facilitates changes in the photocatalytic properties of the material.

To summarize chapter-wise, the halide-based perovskite (Cesium Lead Bromide) has been utilized as a fluorescence sensing probe for detecting various analytes in this thesis. The correlation of defect chemistry with the photocatalytic properties of calcium copper titanate perovskite has also been further explored. The significant outcomes of this thesis are given below:

**Chapter 1**

i) Different properties of perovskites and their classifications are mentioned,

ii) The various synthetic routes of perovskites are highlighted, and

iii) Applications of perovskites are mentioned.

**Chapter 2**

i) The bright green luminescent $CsPbBr_3$ perovskites dispersion has been successfully designed as a successful fluorescence and colorimetric sensing probe for detecting uric acid, and

ii) The selectivity and sensitivity performance of $CsPbBr_3$ in different physiological performance has been further studied.

**Chapter 3**

i) Chemical stabilities of halide-based perovskite (Cesium Lead Bromide, $CsPbBr_3$) upon in-situ passivation of different cationic, anionic, and non-ionic surfactants are addressed,

ii) The most stable cetyl tri-methyl ammonium bromide (CTAB)-passivated $CsPbBr_3$ was demonstrated as a dual ratio-metric fluorescence sensor for alcohols, and

iii) CTAB@$CsPbBr_3$ can be able to selectively sense alcohols and successfully differentiate ethanol from other alcohols.

iv) The bright green luminescent $CsPbBr_3$ perovskites dispersion has been successfully designed as a successful fluorescence and colorimetric sensing probe for detecting uric acid, and

v) The selectivity and sensitivity performance of $CsPbBr_3$ in different physiological performance has been further studied.

**Chapter 4**

i) The luminescence stability of oleic Acid and *p*-thiocresol ligand passivated $CsPbBr_3$ in different physiological conditions has been developed, and

ii) The designed stable fluorescence sensor probe has been successfully applied for detecting the target analyte cholesterol.

**Chapter 5**

i) The Calcium Copper Titanate based perovskite materials have been synthesized by citrate precursor method by changing the molar ratios of $Ca^{2+}$ and $Cu^{2+}$,

ii) The photocatalytic behaviours of calcium copper titanate at three compositions ($Ca_xCu_{3-x}Ti_4O_{12}$, where x = 1, 1.5, 2) have been studied through the degradation of Rhodamine Blue dye under the illumination of 20-Watt LED light,

iii) The defect densities of the synthesized materials have been studied through luminescence properties,

iv) A comparative study of degradation efficiency and rate constant with the defect concentration has been established.

## 6.2 Future-scope of this work

The majority of the works in this thesis mainly emphases on different fluorescence sensing and photocatalytic application of metal-halide and metal-oxide based perovskite materials. Although a plethora work has been done on the synthesis of perovskite to find and tune the stability and the optoelectronic properties, there are still some challenges to be addressed to use perovskite material for different applications like sensing and catalysis. Some of the future scopes on the basis of the present research studies are:

i) Development of new synthetic methodologies towards metal-halide perovskites to achieve better stabilities and evaluation of the structure-property relation.

ii) Exploration of metal mixed halide perovskites towards sensing applications.

iii) Exploration of different oxide-based perovskites for the sensing application.

iv) Exploration of the photocatalytic properties of oxide-based perovskites for waste-water treatment.