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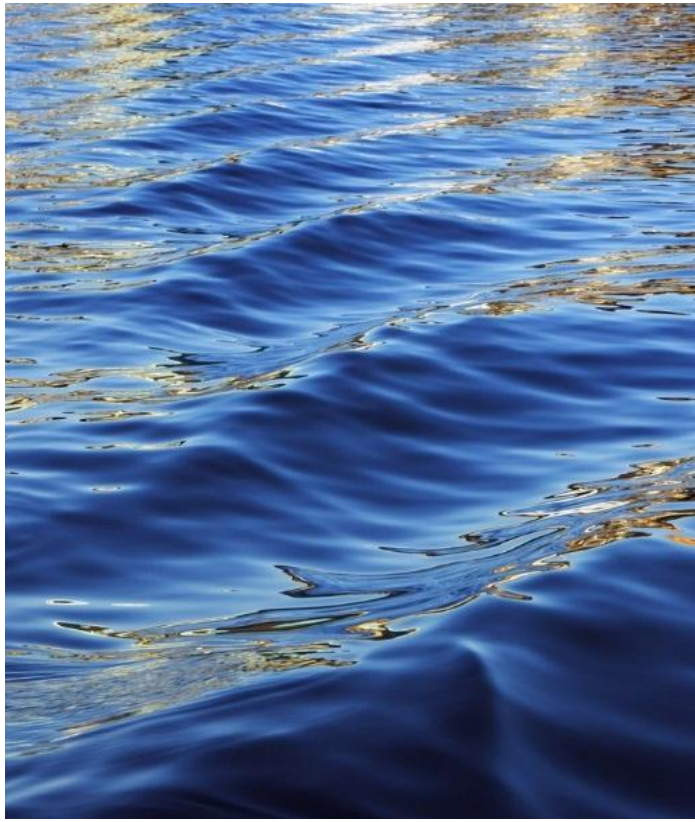


18-20th NOVEMBER, 2026

DEPARTMENT OF PHYSICS

BODOLAND UNIVERSITY, KOKRAJHAR, ASSAM, INDIA





Abstract ID: A067-Solvothermal Synthesis of Cu-Doped $SrTiO_3$ Nanoparticles: Structural, Optical and Electrochemical evaluation for Energy and Environmental applications

Presented by:

PHULMANI BASUMATARY

Research Scholar

Department of Physics

BODOLAND UNIVERSITY

Supervisor

DR. ANJALU RAMCHIARY

ASST. PROFESSOR

DEPT. OF PHYSICS

BODOLAND UNIVERSITY

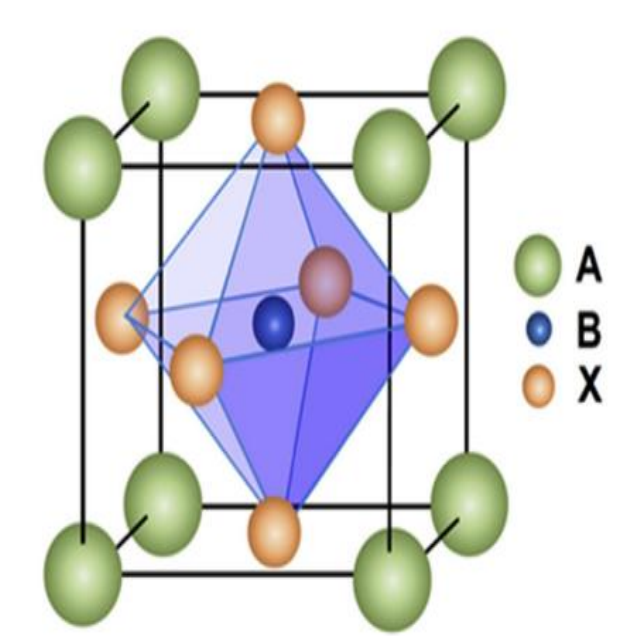
Presentation Outline

1. INTRODUCTION
   - Perovskite Materials
   - Advantages of $SrTiO_3$
2. Synthesis of pure $SrTiO_3$ and Cu-doped $SrTiO_3$
3. Characterizations
4. Electrochemical evaluations
5. Conclusions
6. References
7. Acknowledgements

1. INTRODUCTION

Perovskite Materials

- General Chemical formula of Perovskite materials is ABX_3
- X may be oxides, halides or nitrides.
- A-site elements *Cs, Na, Rb, Ba, Sr, La, Nd*, etc influences the structure and stability of the material.
- B-site elements are like *Co, Nb, Ru, Au, Ti*, etc impacts the photocatalytic activity



Moniruddin et.al Materials Today Energy 7(2018)

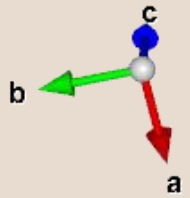
Fig.1 ABX_3 perovskite unit cell

1. INTRODUCTION

$SrTiO_3$

Advantages of $SrTiO_3$:

- **Remarkable photostability**
- **Nontoxicity**
- **Cost effective synthesis**



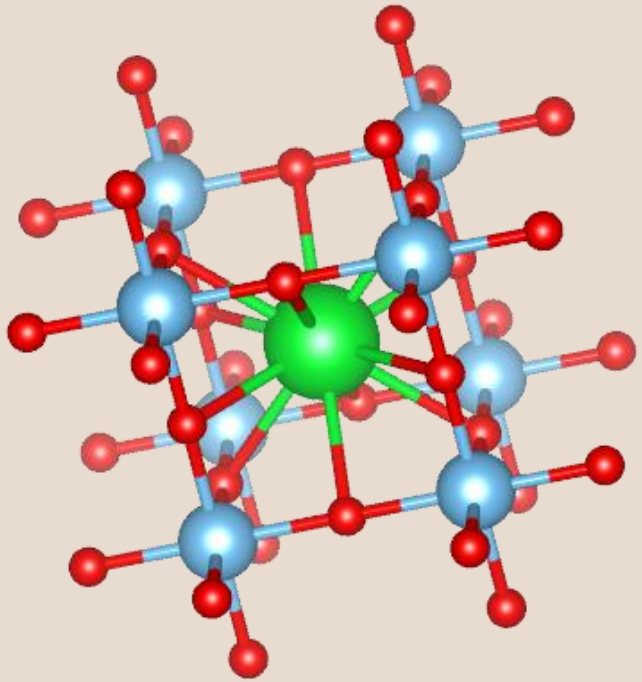


Fig.2 $SrTiO_3$ perovskite unit cell

2. SYNTHESIS METHOD

Synthesis of pristine $SrTiO_3$ and Cu-doped $SrTiO_3$

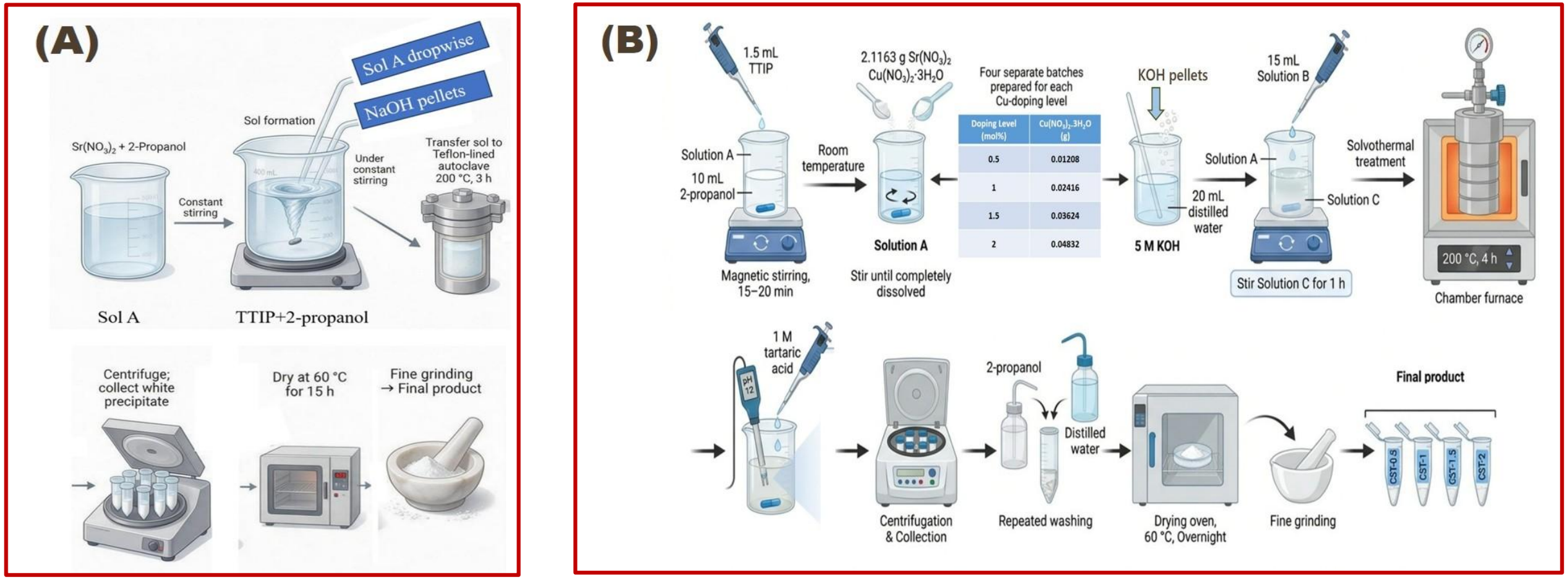


Fig.3 Schematic block diagram of synthesis of (A) pure $SrTiO_3$ and (B) Cu-doped $SrTiO_3$ at different concentrations

3. Characterizations

X-Ray Diffraction

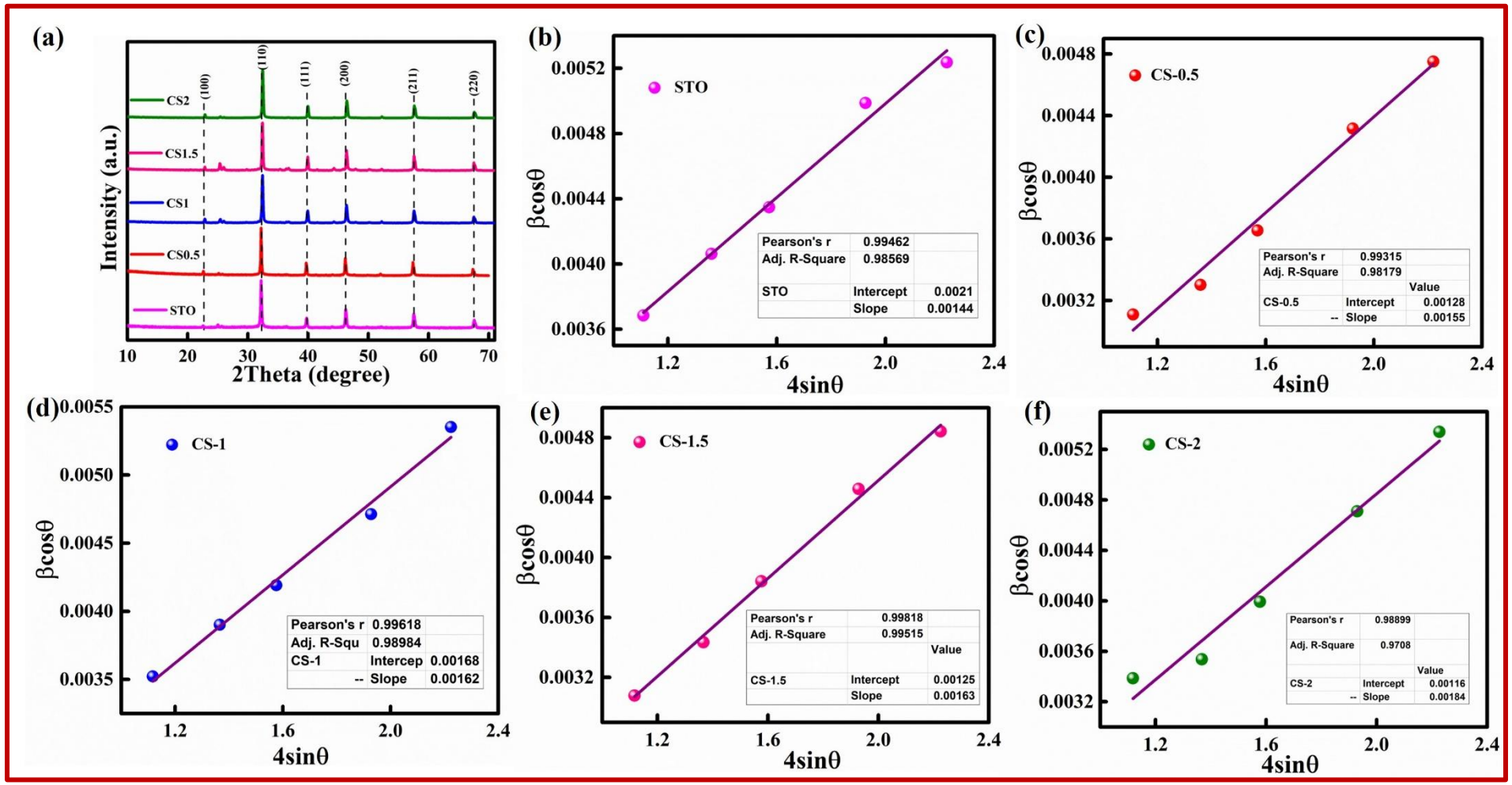


Fig.4: (a)XRD pattern and (b-f) W-H plot of pure $SrTiO_3$(STO) and Cu-doped STO (CS)at different doping concentrations

3. Characterizations

X-Ray Diffraction

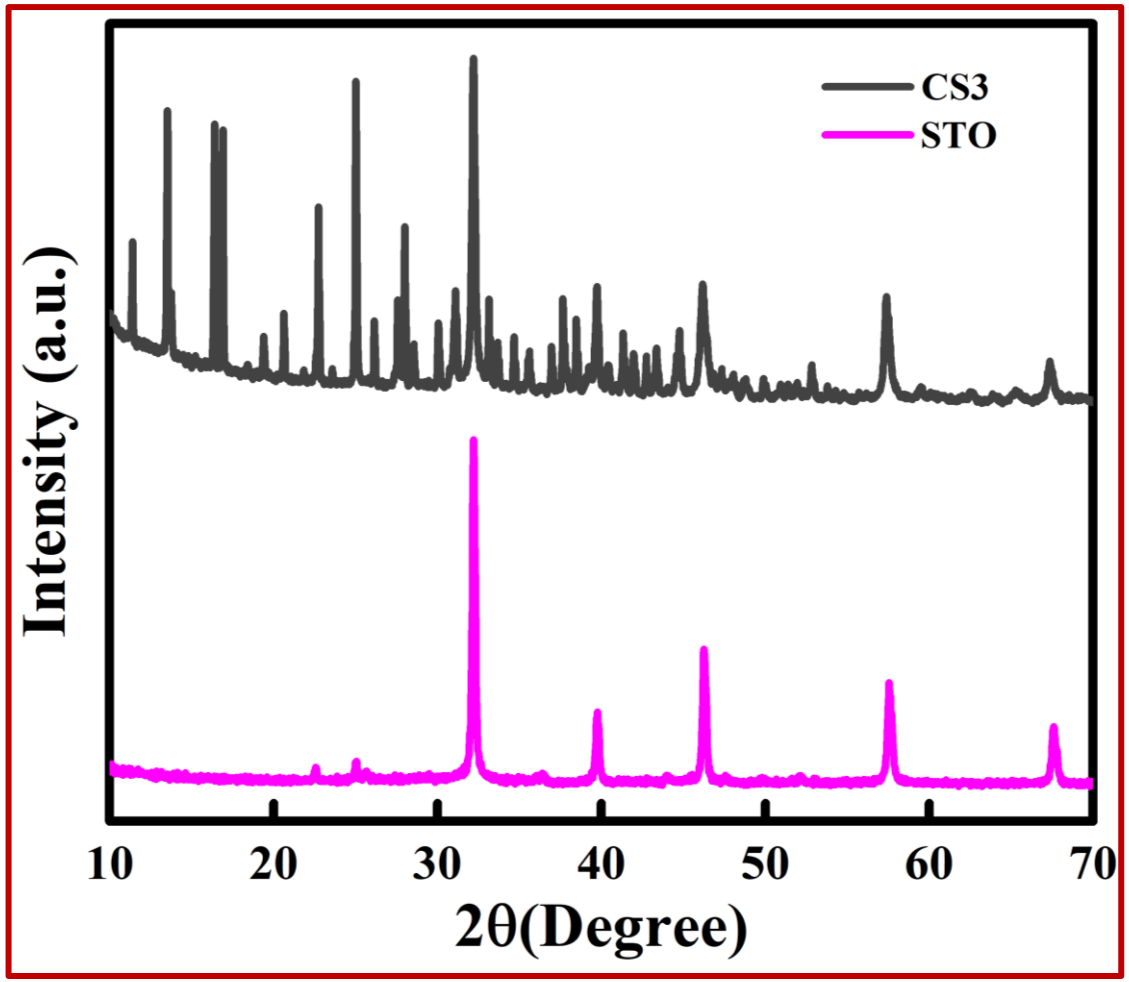


Fig.5: (a)XRD of pure $SrTiO_3$(STO) and 3mol% Cu-doped STO (CS3

3. Characterizations

X-Ray Diffraction

Table1: Different parameters calculated from XRD analysis for each samples

Material	Crystallite Size(nm)	Inter planer Spacing(Å)	Lattice Parameter (Å)
Pristine STO	39.3	2.77	3.910
CS0.5	50.4	2.77	3.910
CS1	41.8	2.75	3.903
CS1.5	46.9	2.75	3.903
CS2	40.6	2.75	3.903

Crystallite size:
Scherrer equation

$$D = \frac{k\lambda}{\beta \cos\theta} \quad (1)$$

Interplanar spacing:
Bragg equation

$$d = \frac{\lambda}{2 \sin\theta} \quad (2)$$

Lattice parameter:

$$a = d\sqrt{h^2 + k^2 + l^2} \quad (3)$$

3. Characterizations

UV-Vis DRS

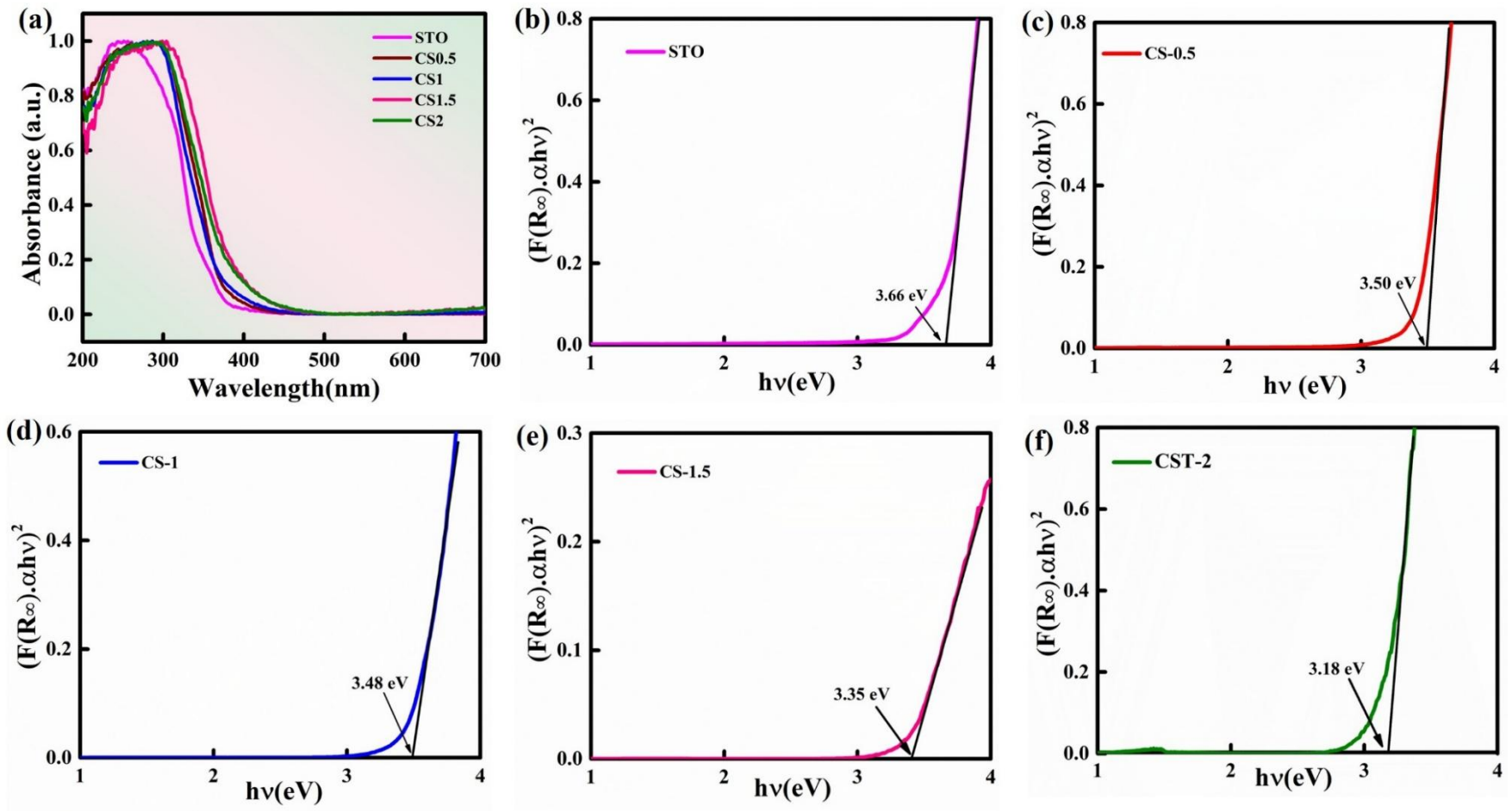


Fig.6(a) Absorbance spectra and (b-f) Tauc's plot for determining direct band gap of pure $SrTiO_3$ and Cu-doped $SrTiO_3$ samples

3. Characterizations

UV-Vis DRS

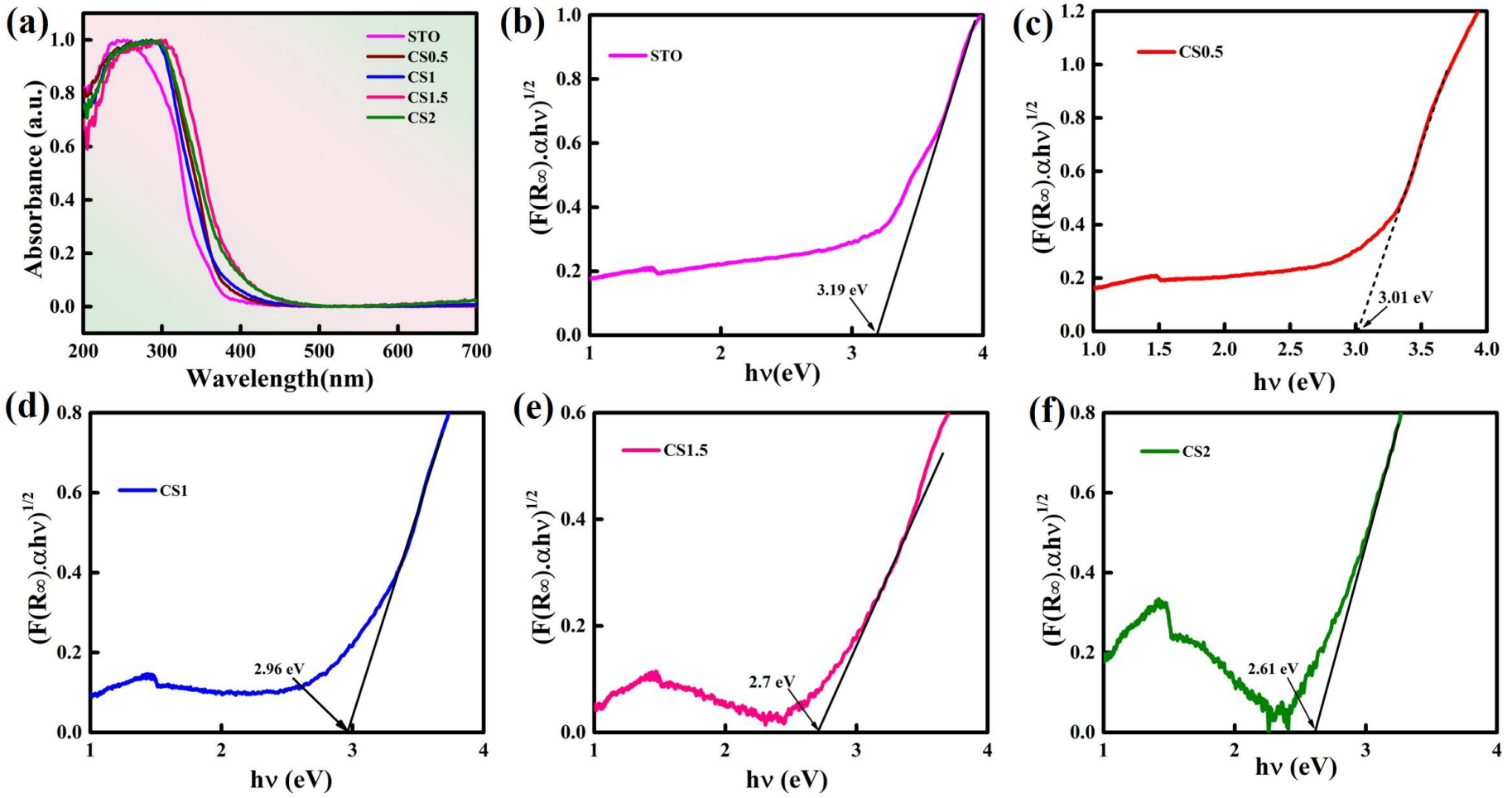


Fig.7(a) Absorbance spectra and (b-f) Tauc's plot for determining indirect band gap of pure $SrTiO_3$ and Cu-doped $SrTiO_3$ samples

3. Characterizations

SEM Images

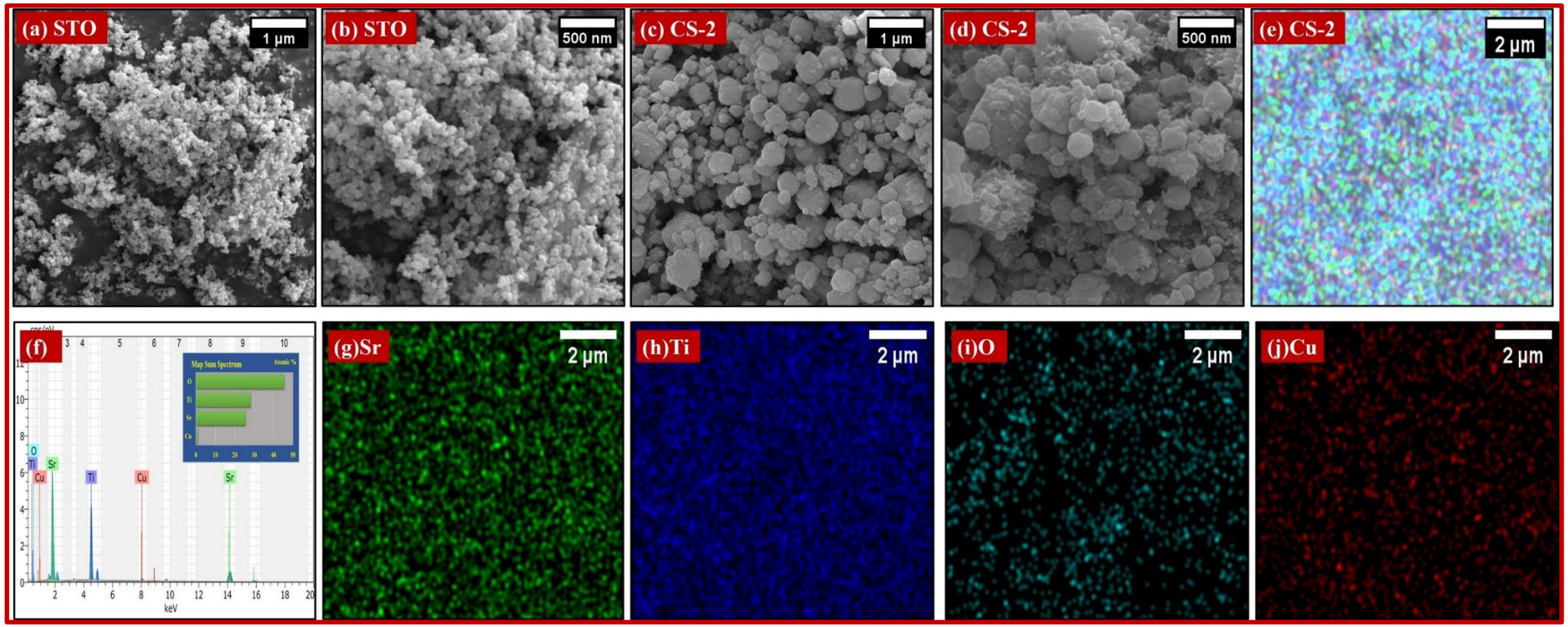


Fig.8: FE-SEM images of pure $SrTiO_3$(a-b) and CS-2 (c-d), EDS and elemental mapping of constituent elements of CS-2(e-j)

3. Characterizations

TEM Images

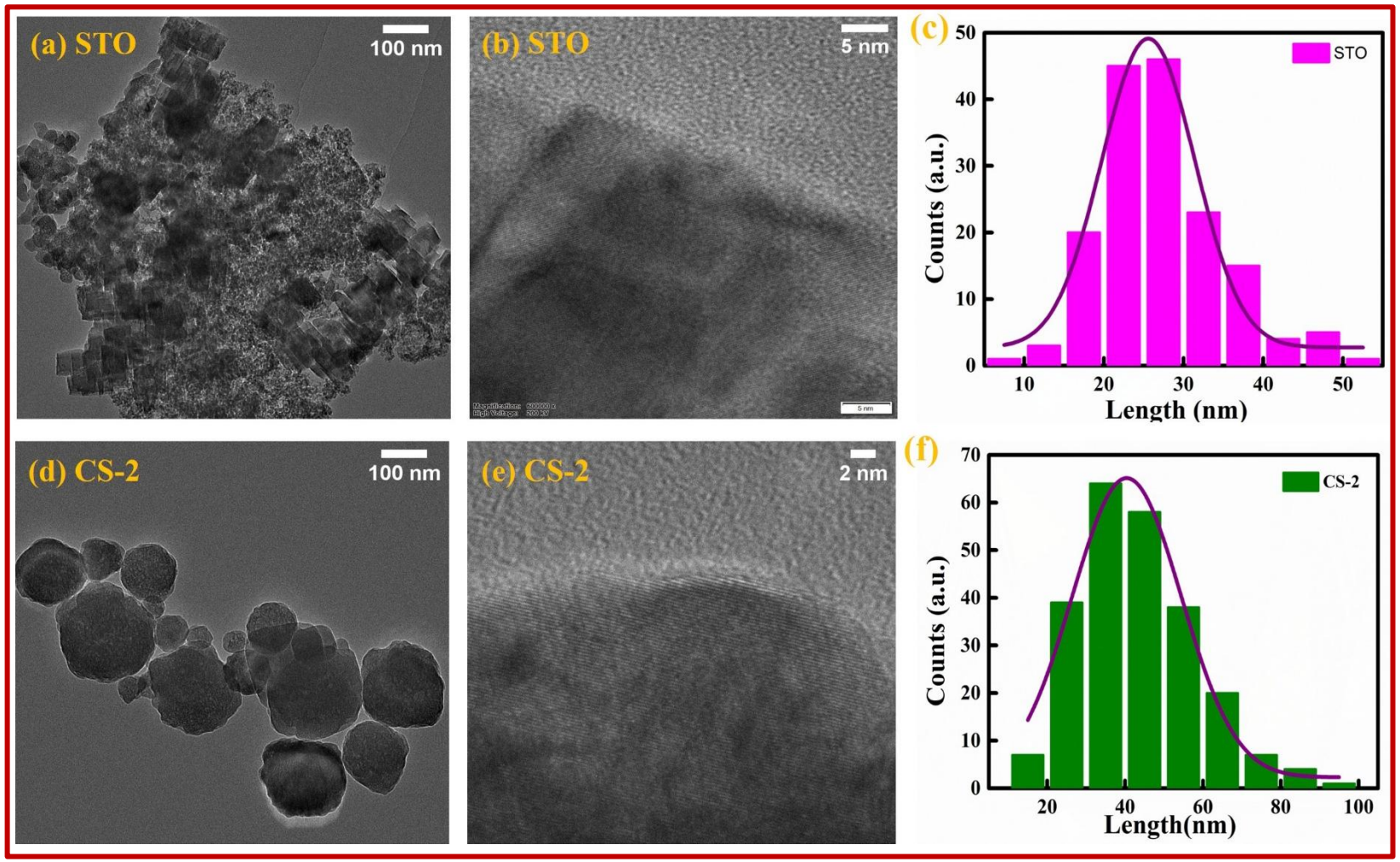


Fig.9: TEM, HR-TEM and particle size histogram of pure $SrTiO_3$(a-c) and CS-2(d-f) samples respectively

3. Characterizations

XPS

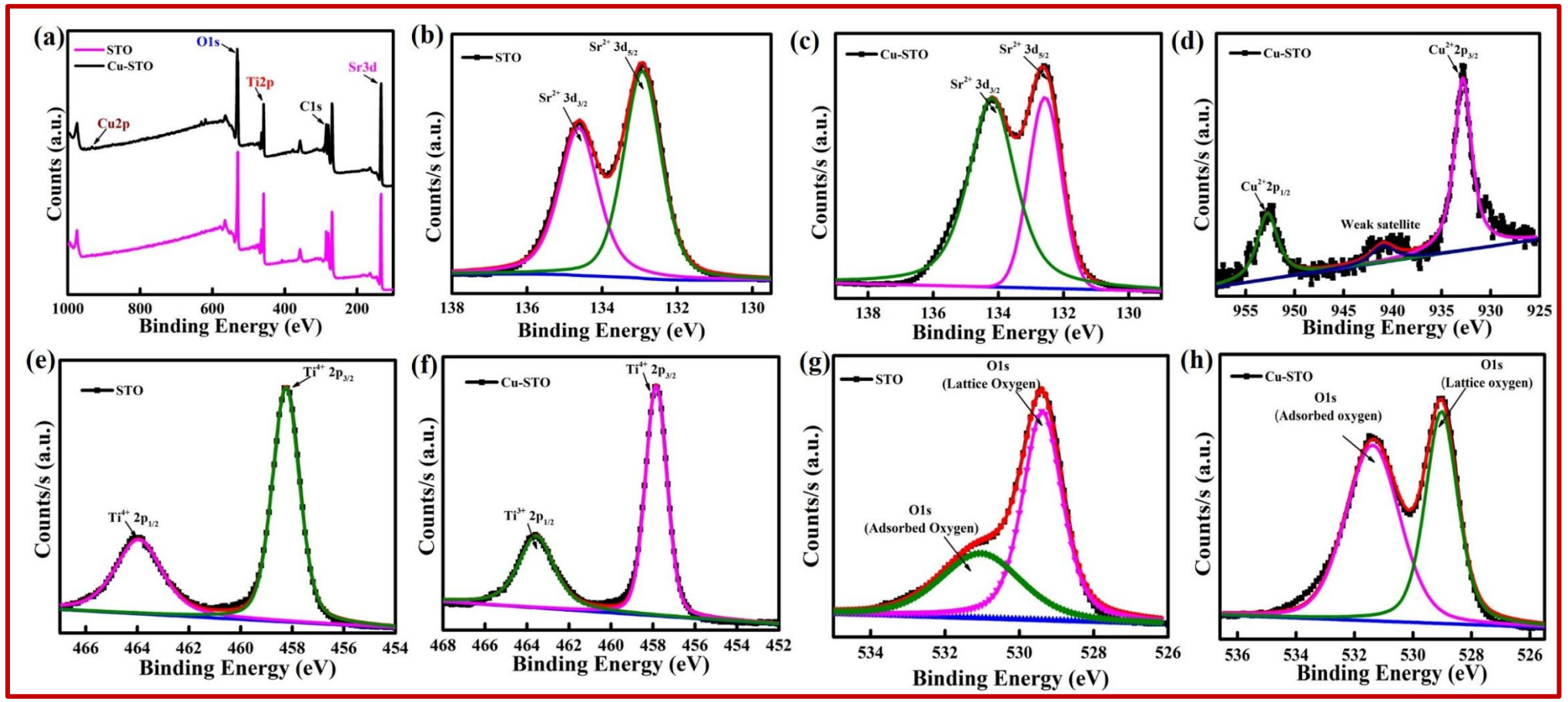


Fig.10: (a)XPS survey spectra of pure $SrTiO_3$ and Cu-doped $SrTiO_3$ and core-level peak fitting of the constituent elements(b-c) Sr, (d) Cu, (e-f) Ti and (g-h) O

3. Characterizations

XPS

Table2: Binding Energy Peaks and Oxidation states of constituent elements in pure $SrTiO_3$ and CS-2 samples

Sample	Element	Binding Energy (eV) and Oxidation state	
$SrTiO_3$	Sr	134.6($Sr3d_{3/2}$)	132.9($Sr3d_{5/2}$)
	Ti	464 ($Ti2P_{1/2}$)	458($Ti2p_{3/2}$)
	O	531 (adsorbed oxygen)	529.3(lattice oxygen)
CS-2	Cu	952.8($Cu2p_{1/2}$)	932.9($Cu2p_{3/2}$)
	Sr	134.2($Sr3d_{3/2}$)	132.6($Sr3d_{5/2}$)
	Ti	463.6 ($Ti2P_{1/2}$)	457.8($Ti2p_{3/2}$)
	O	531 (adsorbed oxygen)	529(lattice oxygen)

4. Electrochemical evaluation

LSV, Tafel slope and Mott-Schottky analyses

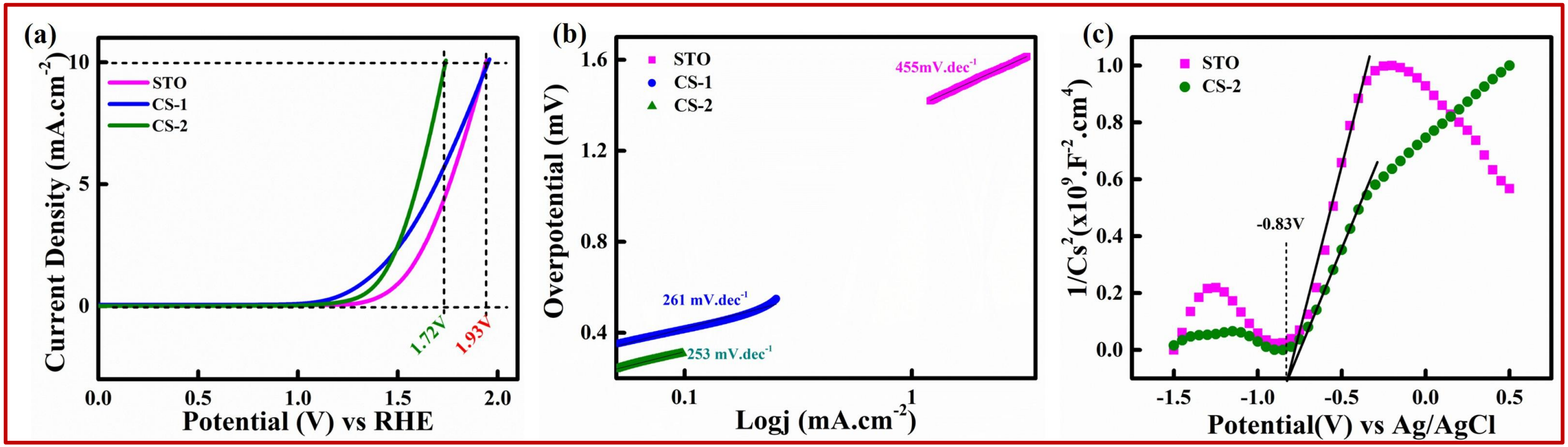


Fig.11: (a)LSV and (b) Tafel slope of pure $SrTiO_3$, CS-1 and CS-2 samples, and (c) Mott-Schottky analysis of Pure $SrTiO_3$ and CS-2 samples

4. Electrochemical evaluation

LSV, Tafel slope and Mott-Schottky analyses

Table3: Different parameters calculated from electrochemical evaluation

Sample	OER Overpotential (mV)	Tafel Slope (mV.dec-1)	Carrier Density N_D (cm^{-3})
$SrTiO_3$	~690	455	8×10^{19}
CS-2	~490	253	2×10^{20}

Conversion equation for Ag/AgCl reference electrode to RHE:

$$E_{RHE} = E_{Ag/AgCl} + (0.059 \times pH) + E^0_{RHE} \quad (4)$$

Carrier Density: Mott-Schottky equation

$$\frac{1}{C_s^2} = \frac{2}{\varepsilon\varepsilon_0 A^2 e N_D}\left(V - V_{fb} - \frac{k_B T}{e}\right) \quad (5)$$

5. *Conclusions*

- ✓ **The crystallite size of pristine STO and Cu doped $SrTiO_3$ (0.5 mole%, 1.0 mole%, 1.5 mole%, 2.0 mole%) are 39.3nm, 50.4nm, 41.8nm, 46.9nm and 40.6 nm respectively.**
- ✓ **The micro strain determined from W-H plot are: 1.44, 1.55.1.62.1.63 and 1.84 for pure STO, CS0.5, CS1, CS1.5 and CS2 respectively.**
- ✓ **The indirect band gaps were found to be 3.19 eV for pristine $SrTiO_3$, 3.01 eV for CS0.5, 2.96 eV for CS1, 2.7 eV for CST-1.5 and 2.61 eV for CS2 samples**
- ✓ **SEM and TEM images reveal cuboidal morphology of $SrTiO_3$ in both pristine and Cu-doped $SrTiO_3$ samples.**
- ✓ **XPS analysis gives an insight to the surface electronic properties and oxidation states of constituent elements in both pure $SrTiO_3$ and Cu-doped $SrTiO_3$ samples.**

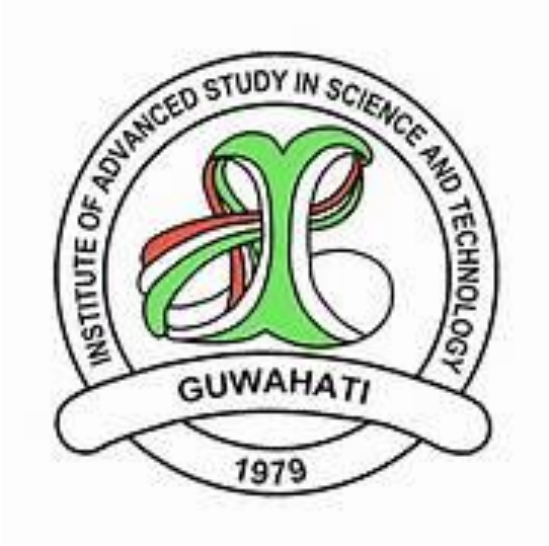
6. References

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7. *Acknowledgements*











THANK YOU ☺