

High yield and environmentally friendly production of lignin containing cellulose nanocrystals

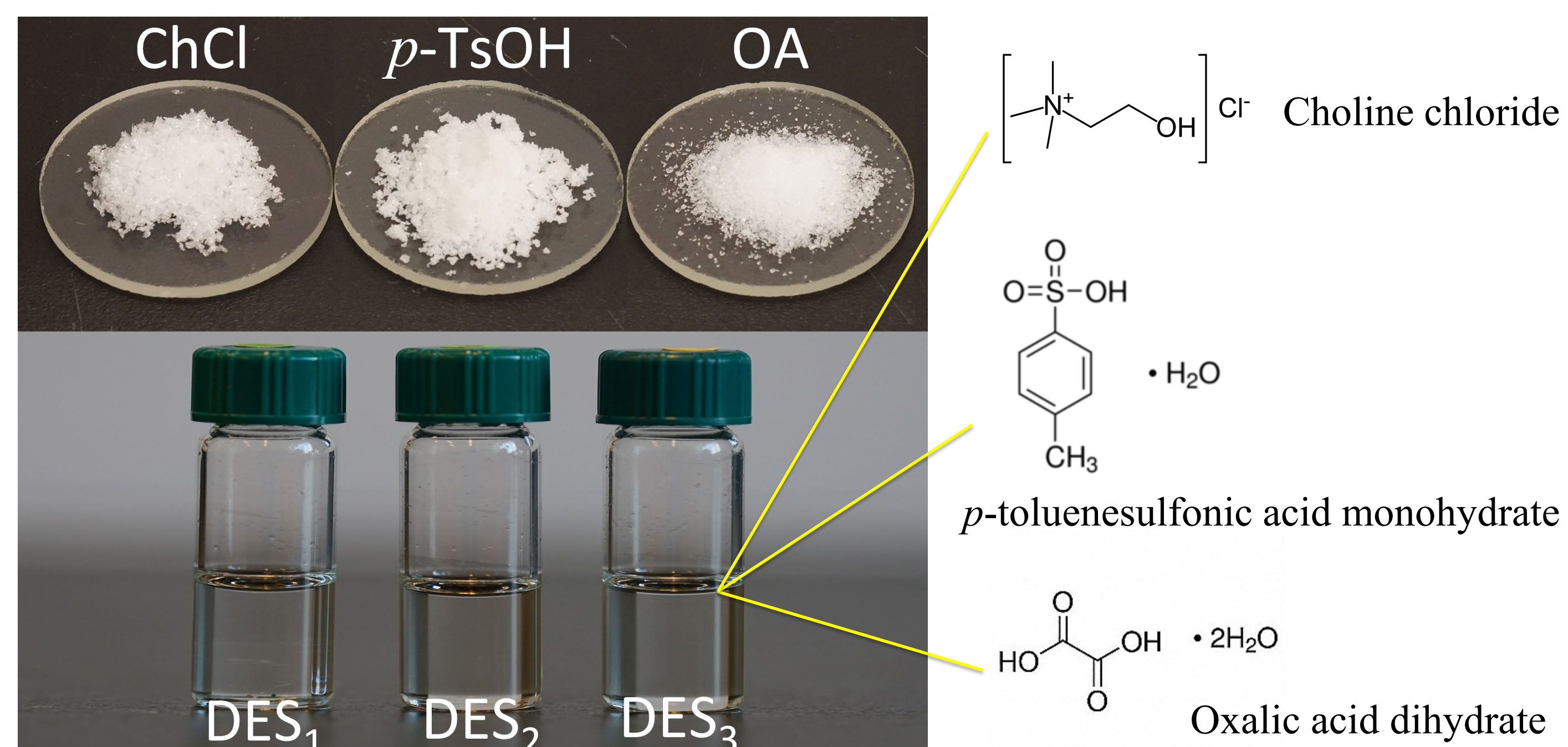
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Background



To satisfy the growing environmental concern caused by fossil materials, and to optimize the utilization of forest resources to promote the bioeconomy in BC province, it is pressing to develop clean technology to produce high value-added forest products such as nanocellulose materials.

Methods



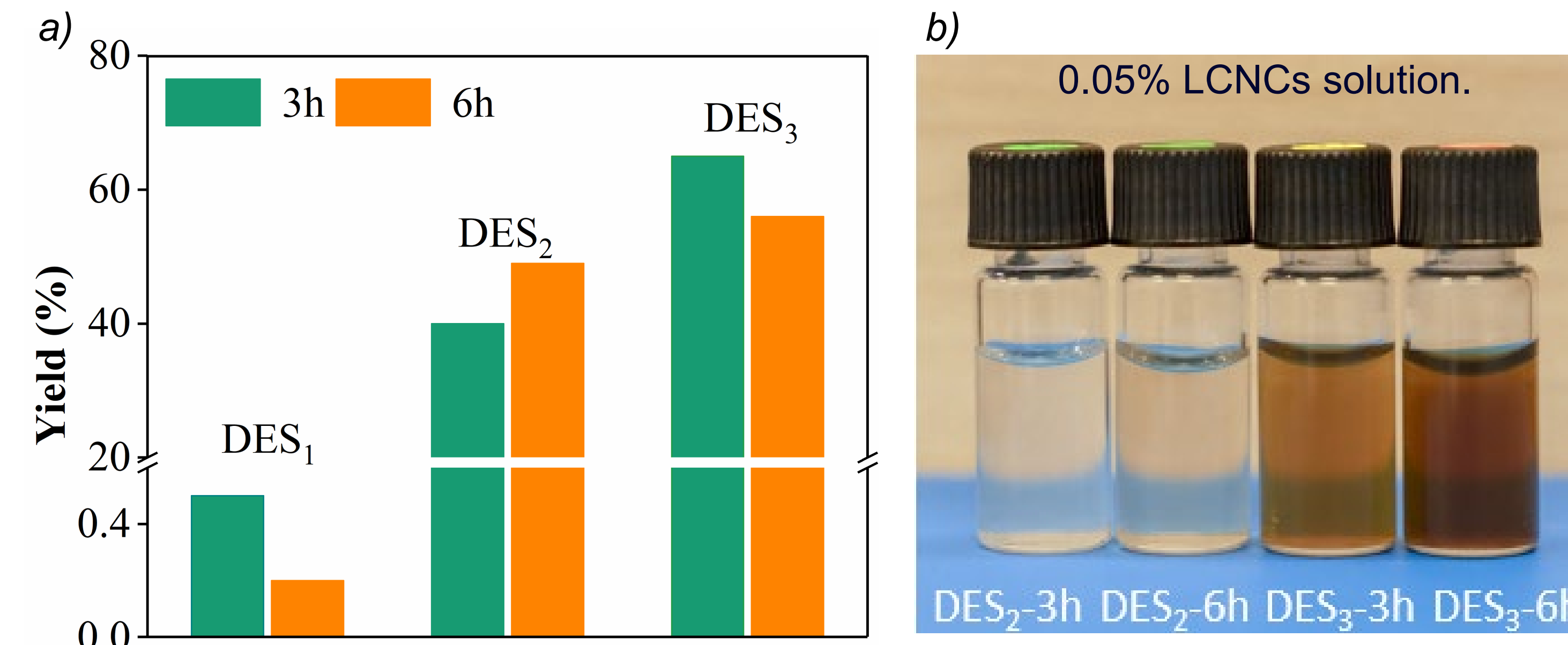
DES₁: ChCl:p-TsOH=1:1, DES₂: ChCl:OA=1:1, DES₃: ChCl:p-TsOH:OA=2:1:1.

Flowchart

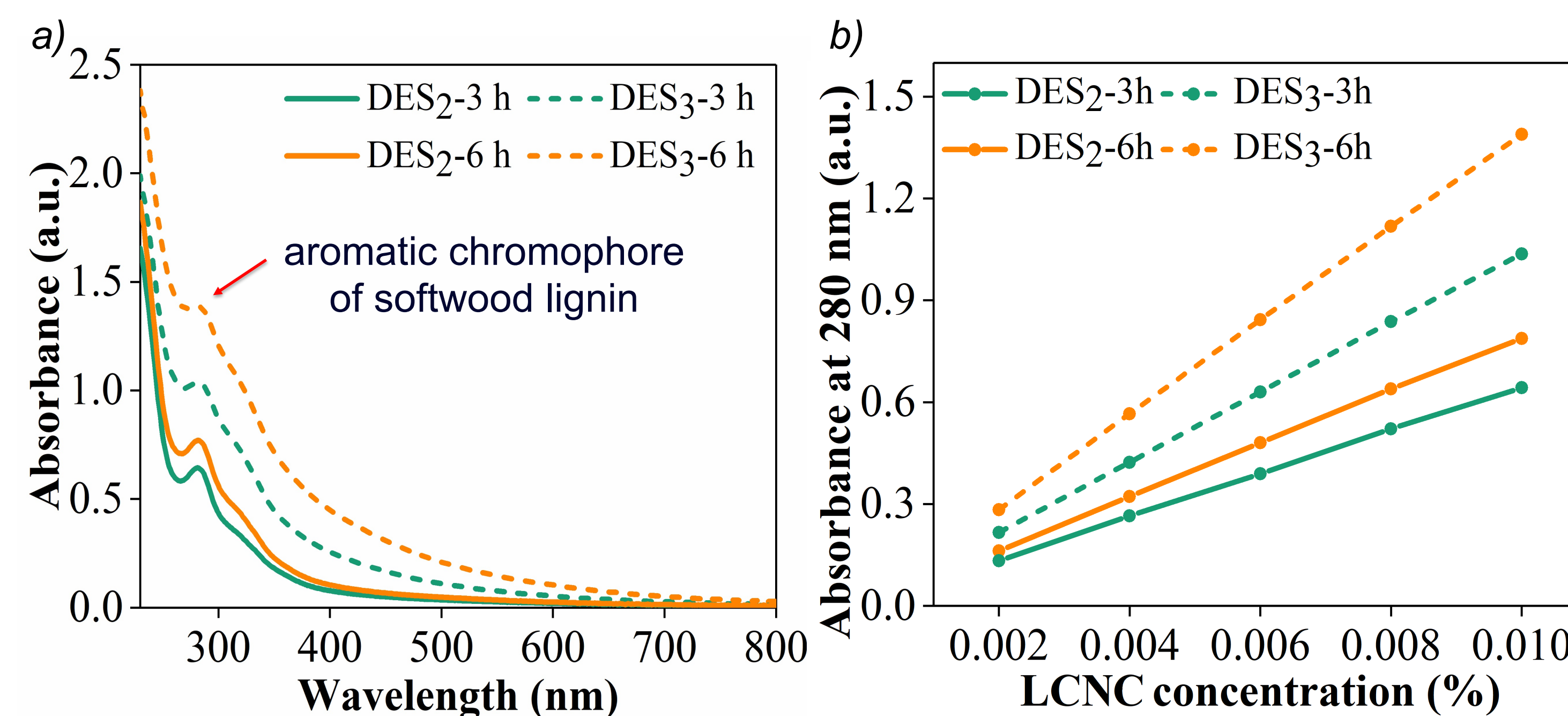


Results

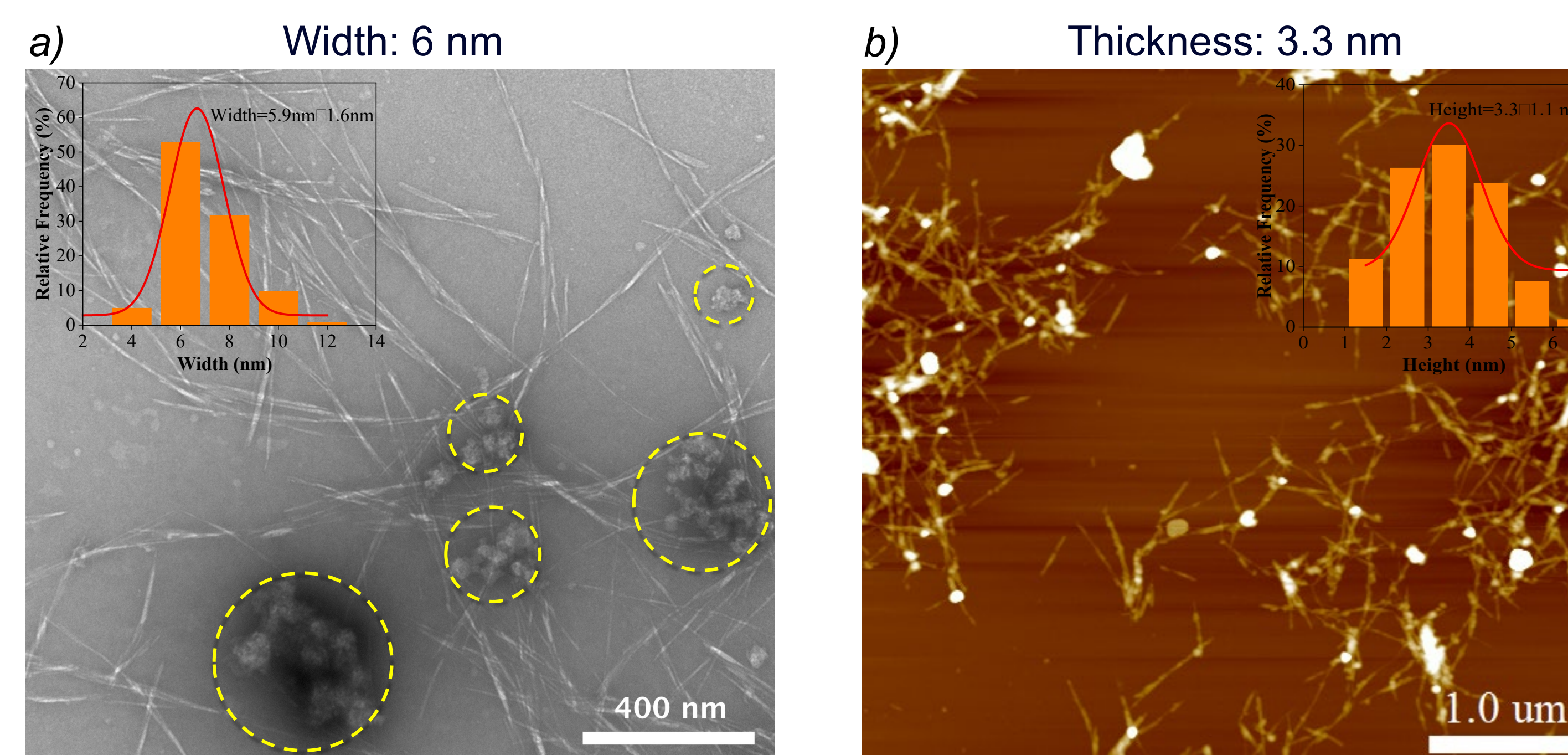
The **highest yield is 66%**, which can be obtained at DES₃-3h;



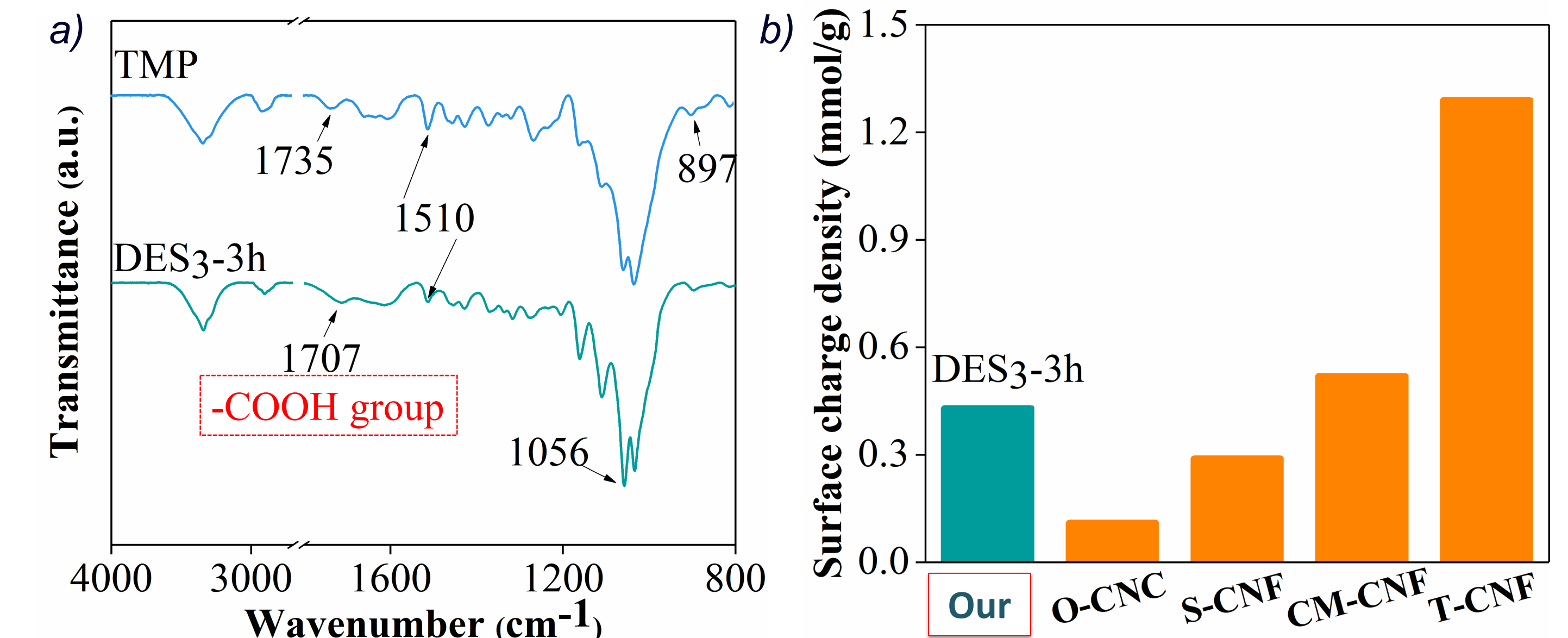
The absorbance at 280 nm increases linearly with increasing LCNC concentration, indicating that the **lignin is evenly distributed** in the suspension.



Ribbon-like structure of the DES₃-3h LCNCs. **Spherical lignin particles and aggregates** can be observed on CNCs.

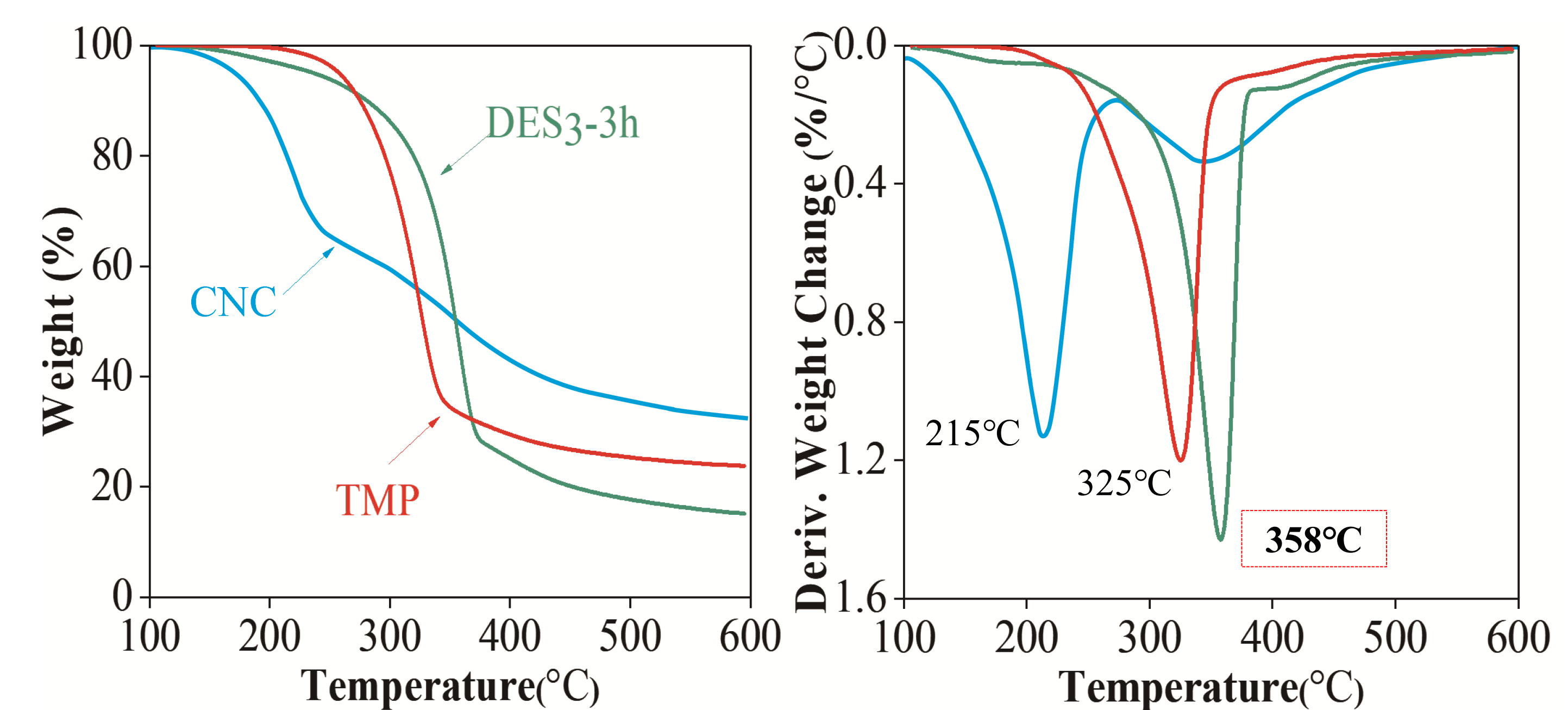


Relative **high surface charge density**: 0.43 mmol/g.



O-CNC (oxalic acid hydrolyzed CNCs), S-CNC (H₂SO₄ hydrolyzed CNC), CM-CNF (carboxymethylated CNF), T-CNF (TEMPO oxidized CNF).

High thermal stability: T_{max} of 358°C



CNC: traditional H₂SO₄ hydrolyzed CNC.

Conclusion

- Lignin containing CNCs (LCNCs) could be isolated from thermomechanical pulp by hydrolysis using deep eutectic solvent at high yield of 66%;
- The lignin contents in LCNCs range from 28.4% to 53.8%;
- The LCNCs from DES₃-3h contains relative high surface charge density of 0.43 mmol/g, due to the esterification with oxalic acid;
- The LCNCs show ribbon-like structure with width of 6 nm from TEM and thickness of 3.3 nm from AFM;
- The LCNCs also show higher thermal stability with T_{max} of 358 °C, higher than the 325 °C for TMP and 215 °C for CNC.