
LUT
University
LAND
OF THE
CURIOUS

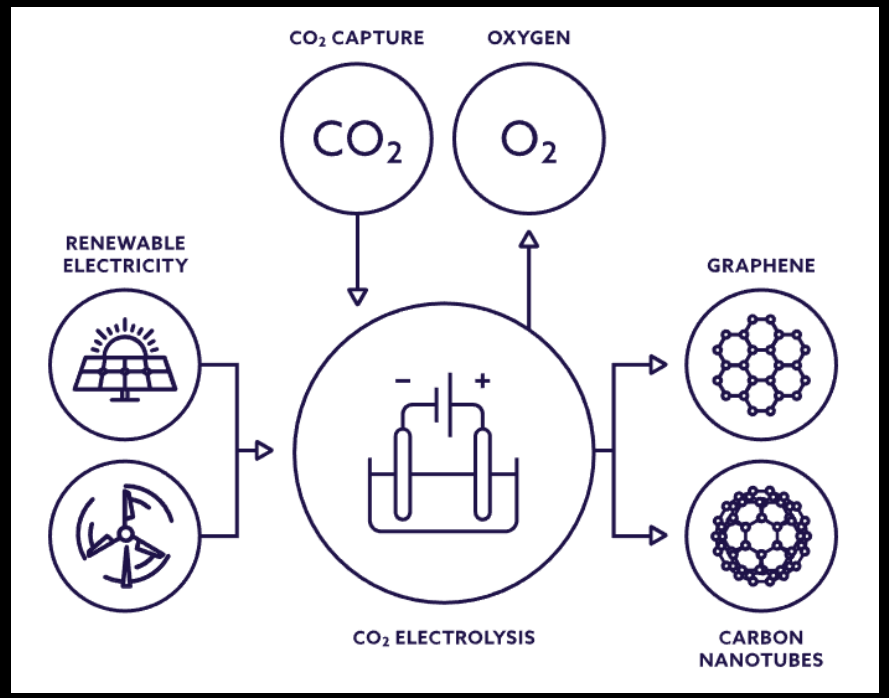
HYGCEL FINAL SEMINAR 1.10.2024

MOLTEN CARBONATE ELECTROLYSIS IN SOLID CARBON PRODUCTION

WP5 / LUT & TAU

Emma Laasonen, M.Sc. (Tech.)
LUT University
emma.laasonen@lut.fi
+358 50 565 1724

CONCEPT OF CO_2 CONVERSION TO CARBON



- Captured CO_2 is electrochemically converted to elementary carbon and oxygen

$$CO_2 \rightarrow C + O_2$$

- With the utilization of renewable electricity carbon negativity may be achieved

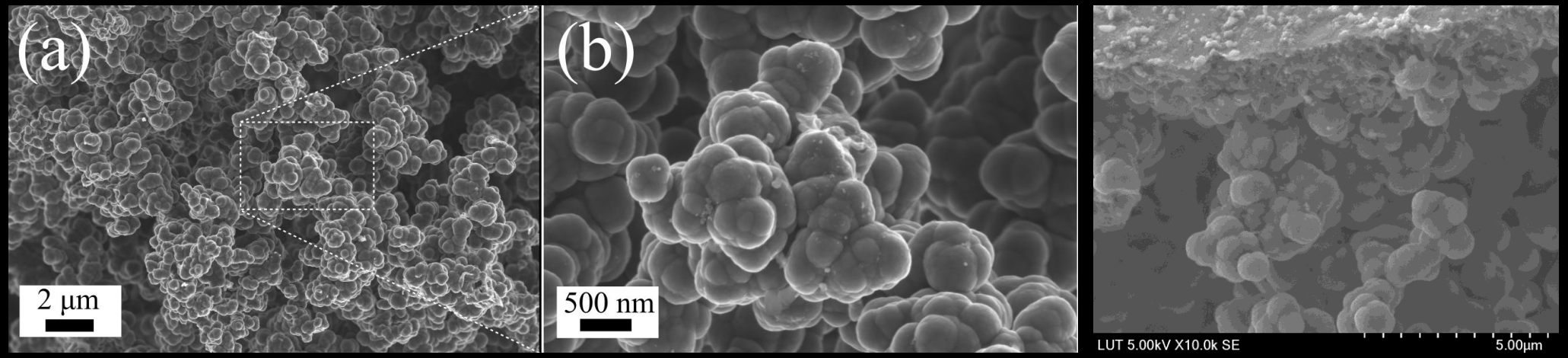
EXPERIMENTAL WORK

- Main parameters:
  - Cathode and anode materials
  - Electrolysis temperature
  - Electrolyte composition
  - Electrolysis current magnitude (*ongoing*)

- Varying these process parameters leads to the production of various carbon products (carbon nanotubes, nano-onions, amorphous carbon etc.)

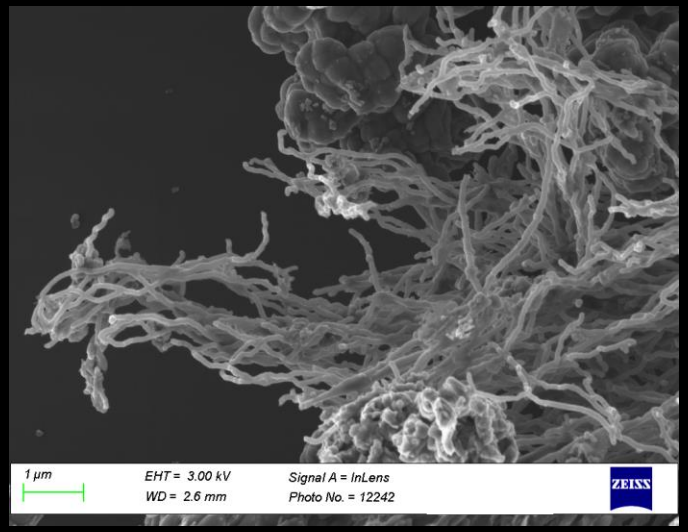
MAIN LEARNING OUTCOMES

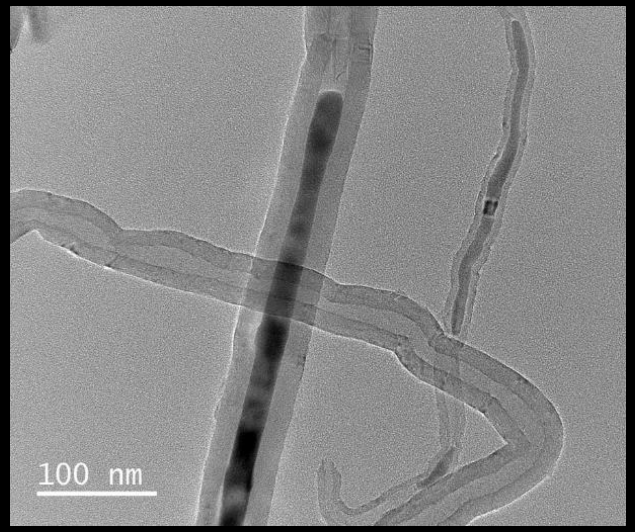
- Highly corrosive process conditions lead to metal impurity formation
- Spherical cauliflower-like structures (nano-onions) have the highest quality and the lowest amount of metallic impurities



MAIN LEARNING OUTCOMES

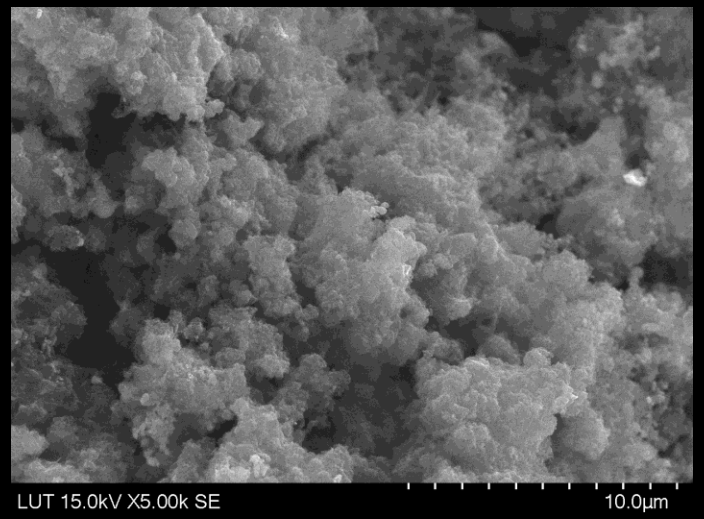
- Tubular structures (nanotubes) are hollow or filled with metal
- Small metal particle nucleates the tube growth

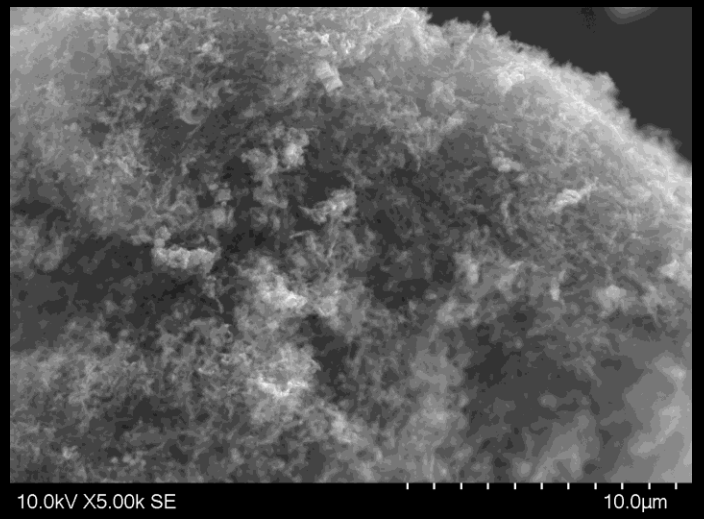




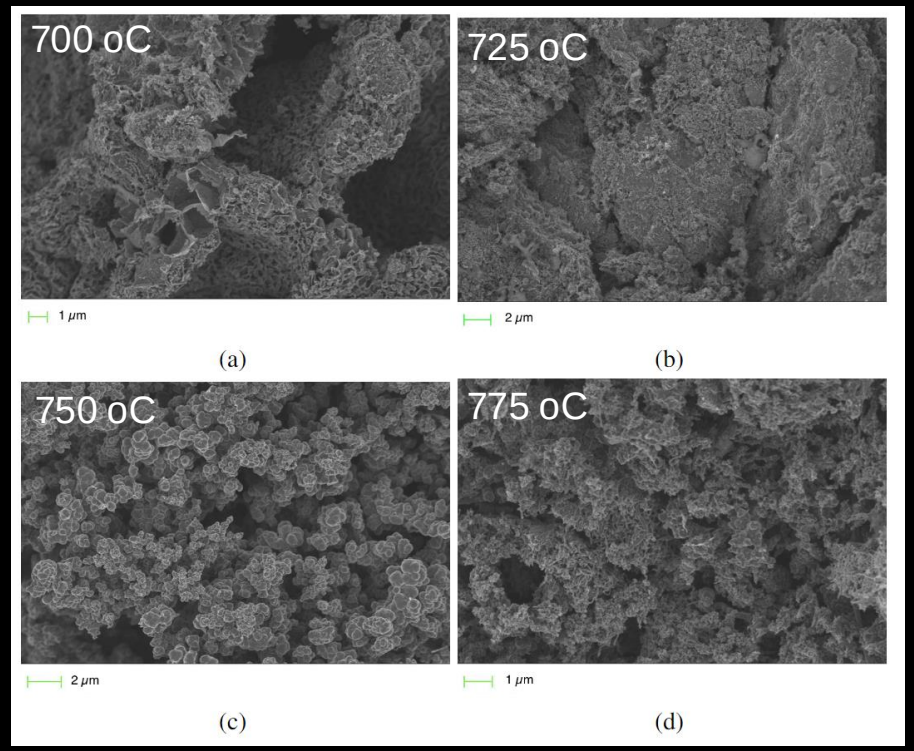
MAIN LEARNING OUTCOMES

- Various different metal impurities at high amounts lead to the production of carbon without any distinct morphology





MAIN LEARNING OUTCOMES



- The process is highly sensitive to temperature changes
  - e.g. Li_2CO_3-$CaCO_3$ electrolyte with Alloy X electrodes with 10A constant current electrolysis

MAIN LEARNING OUTCOMES

- Specific energy consumption (SEC) for electrochemical carbon production is around 20-80kWh/kg carbon
- With conventional methods nanotube SEC is usually >200kWh/kg[1]
- Electrochemical exfoliation of graphite to graphene 500 kWh/kg[2]

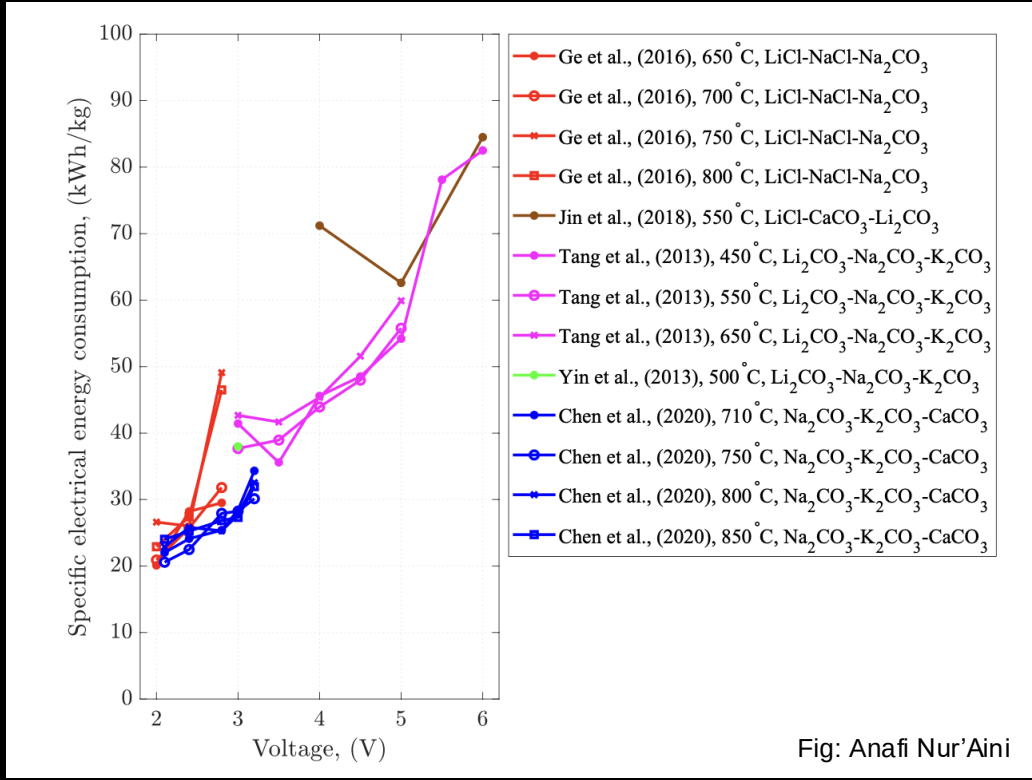


Fig: Anafi Nur'Aini

1. Griffiths, 2014. *Environmental Life Cycle Assessment of Engineered Nanomaterials in Carbon Capture and Utilisation Processes*
2. Jia et al. 2022, *Graphene environmental footprint greatly reduced when derived from biomass waste via flash Joule heating*

CONCLUSIONS

- Highest carbon quality with nano-onions
- Nanotubes contain metal cores
- Higher amount of metal impurities leads to inferior carbon quality
- Multiple morphologies are often found in one sample
- In terms of specific energy consumption electrochemical production of carbon is a viable method

- *The process is highly sensitive → accurate process control and careful material selection are needed to obtain high-quality carbon products*

THANK YOU!!

QUESTIONS?

» Read more:

”Production of elemental carbon via molten carbonate electrolysis: prospects and challenges”
E. Laasonen 2024, *Dissertation*


LUT
University