



**Politecnico
di Torino**

io·li·tec
Ionic Liquids Technologies



Horizon2020
European Union Funding
for Research & Innovation



IONIC LIQUIDS FOR CAPTURE AND ELECTROCHEMICAL CONVERSION OF CO₂

Alessia Fortunati^{1,}, María José Rubio¹, Boyan Iliev², Thomas Schubert², Nunzio Russo¹, Simelys Hernández^{1,*}*

¹ Department of Applied Science and Technology, Politecnico di Torino, Corso Duca degli Abruzzi 24, 10129, Turin, Italy

² Iolitec Ionic Liquids technologies GMBH, Salzstraße 184, 74076 Heilbronn, German

**Email addresses: alessia.fortunati@polito.it; simelys.hernandez@polito.it*



CIS-2021
Young Researchers

Short Talk ID: **S51**
Section 9: CO₂

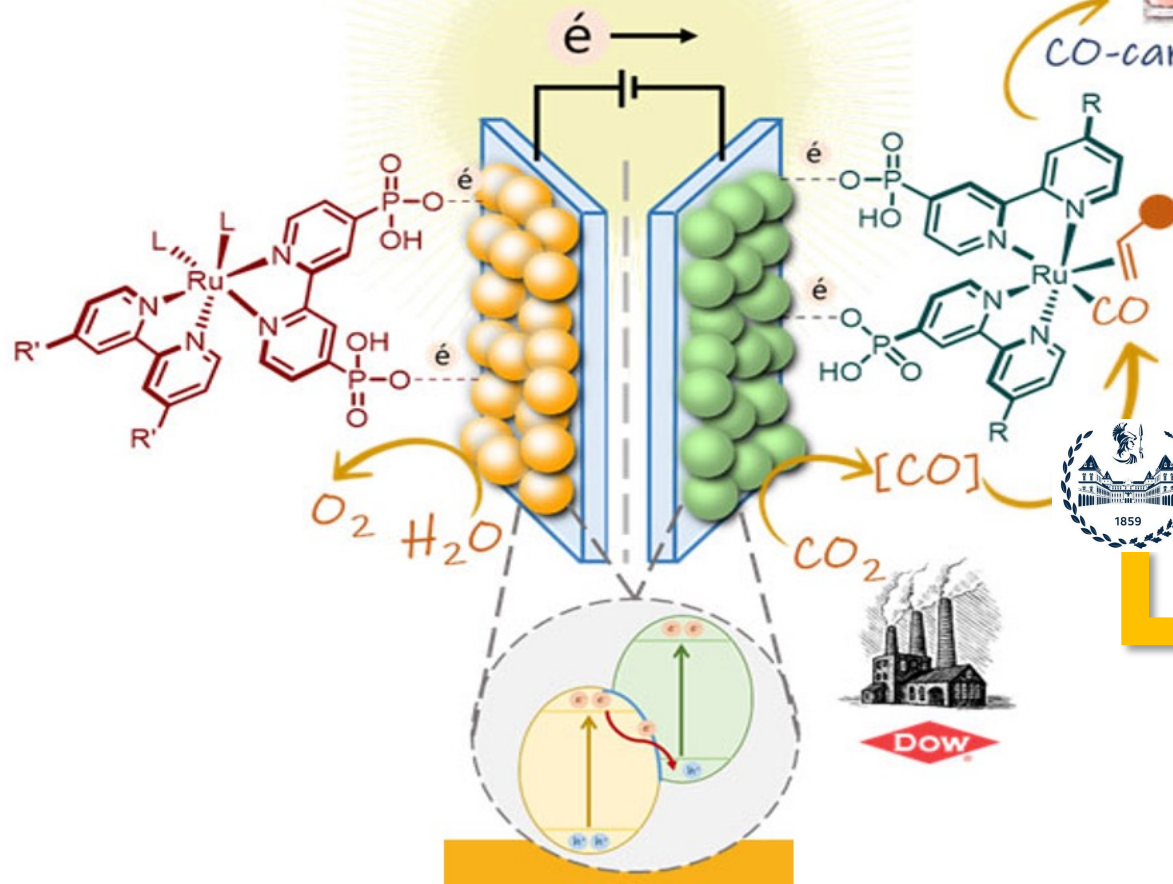
SunCO₂Chem

Photoelectrochemical
Reactor

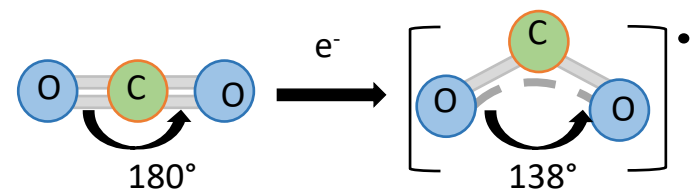
Dow ifff avantium
OXO-Products



CO-carbonylation



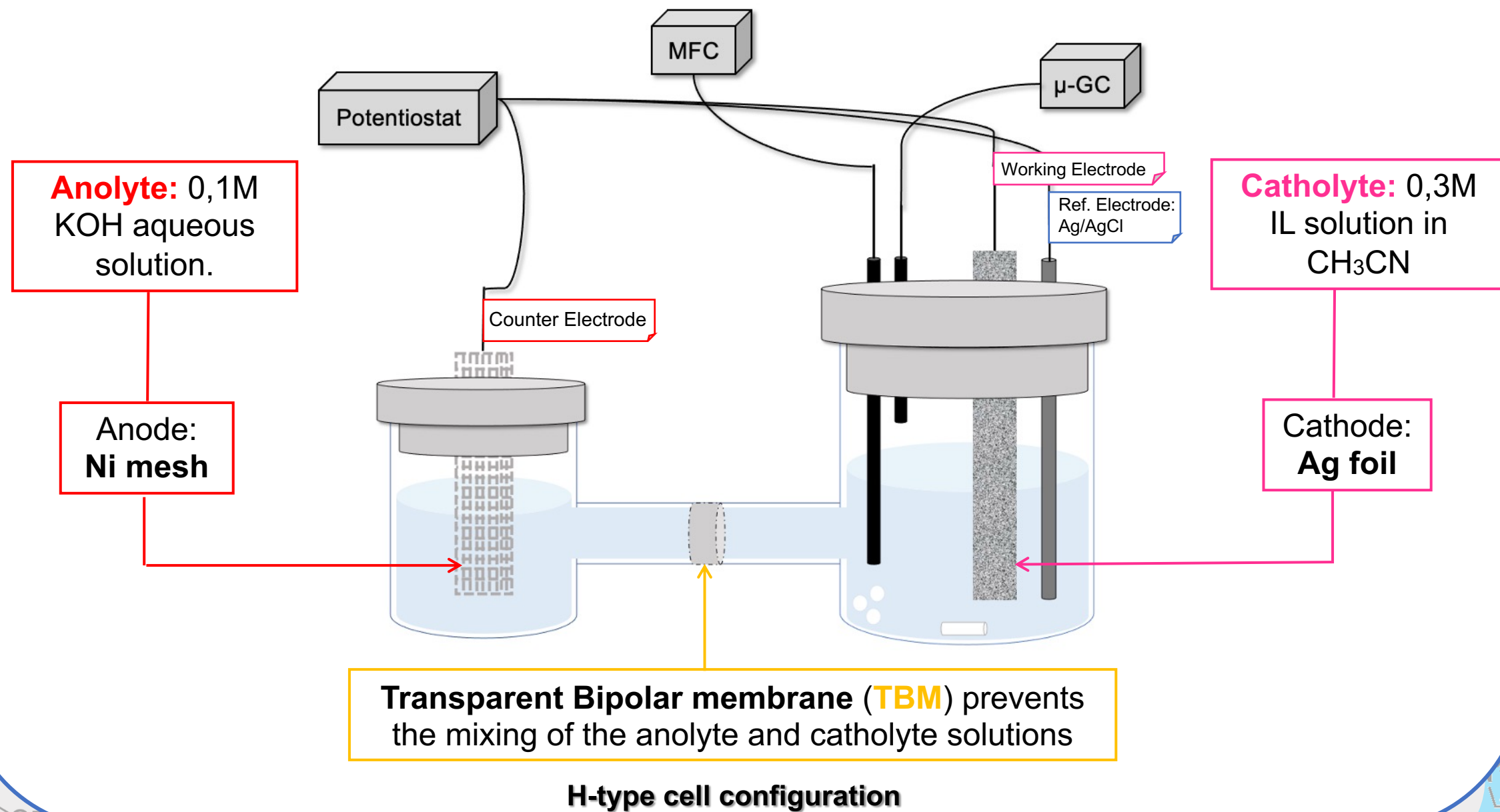
At high current densities, the RDS involved in the CO₂ reduction to CO is the formation of the reactive CO₂^{•-} anion radical.

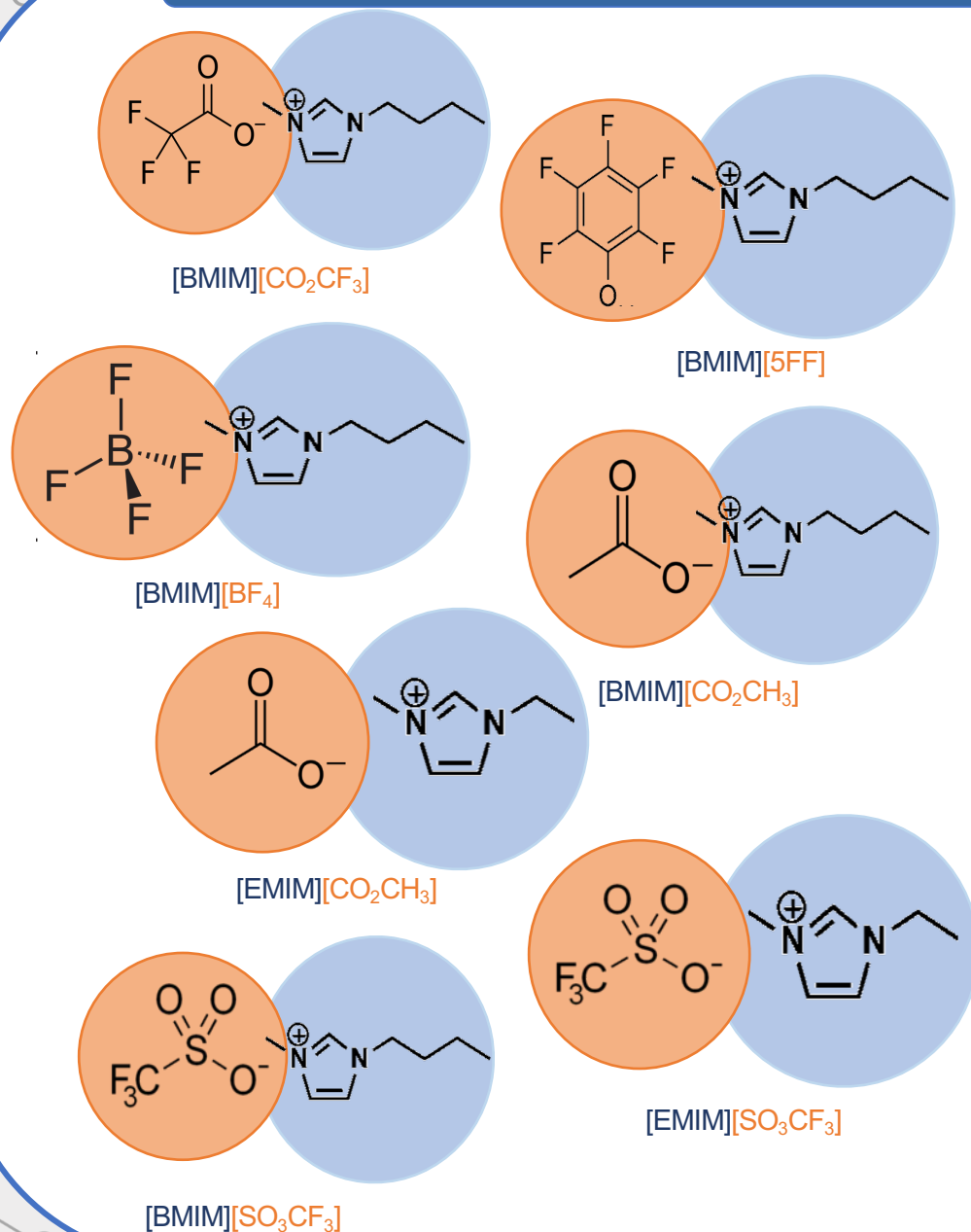


$$E^0 = -1,9V \text{ vs NHE}^1 (\sim -2,1 \text{ vs Ag/AgCl})$$

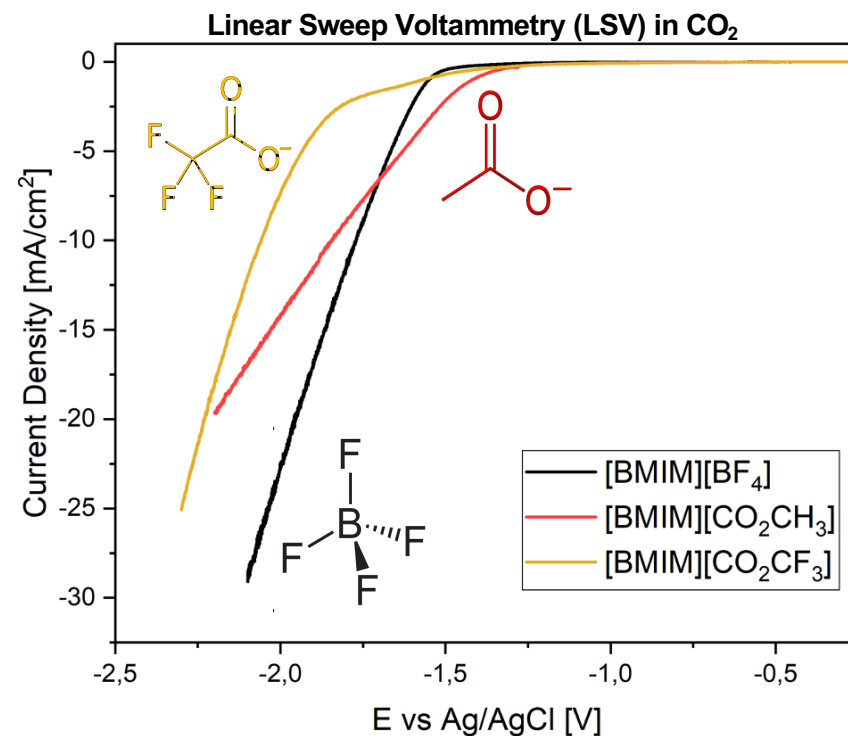
The main objective of this work is to study the influence of different **Ionic Liquids (ILs)** in the performance and selectivity of the electrocatalytic CO₂ reduction to CO.

Materials and methods

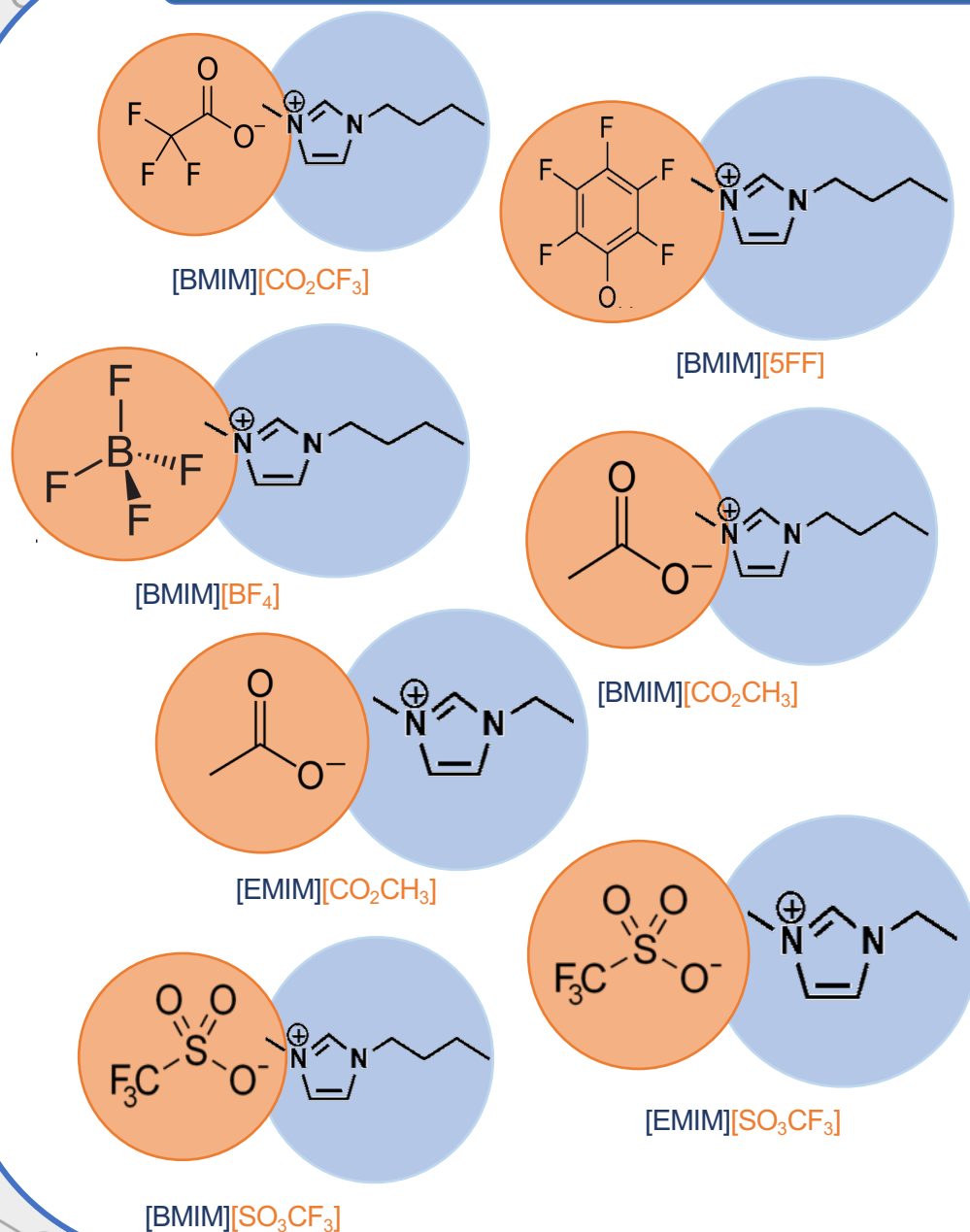




ANION ROLE of IL

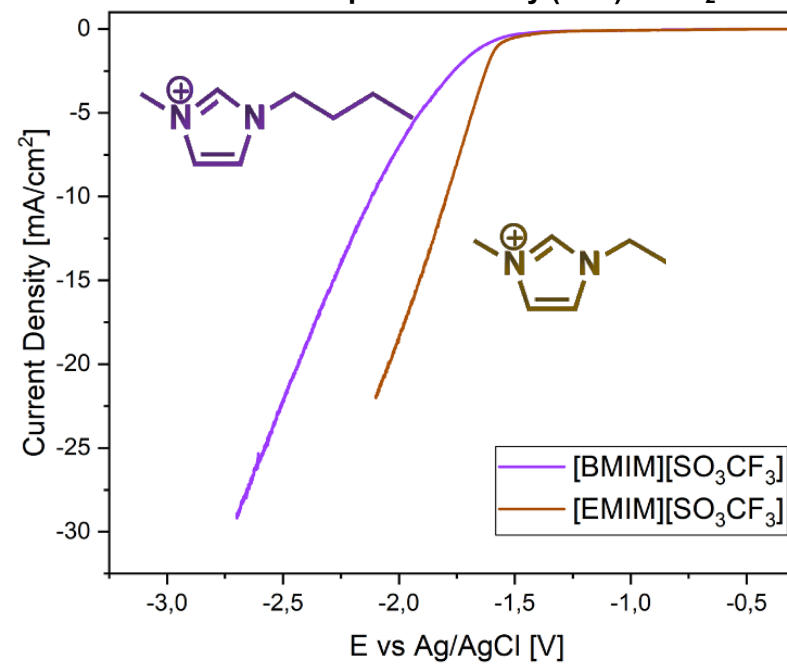


- **CO₂ solubility** strongly depends on the anion influence.
- A higher fluorination degree in the IL leads to a higher CO₂ solubility and current density.
- It might be related to the Fluorine electronegativity.³



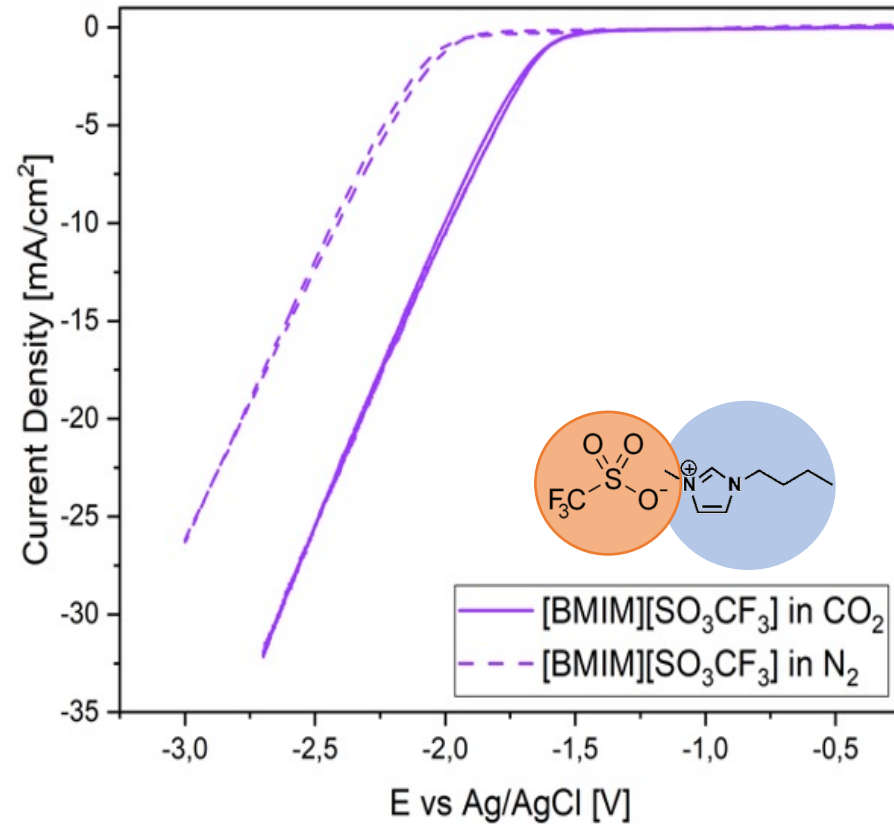
CATION ROLE of IL

Linear Sweep Voltammetry (LSV) in CO₂

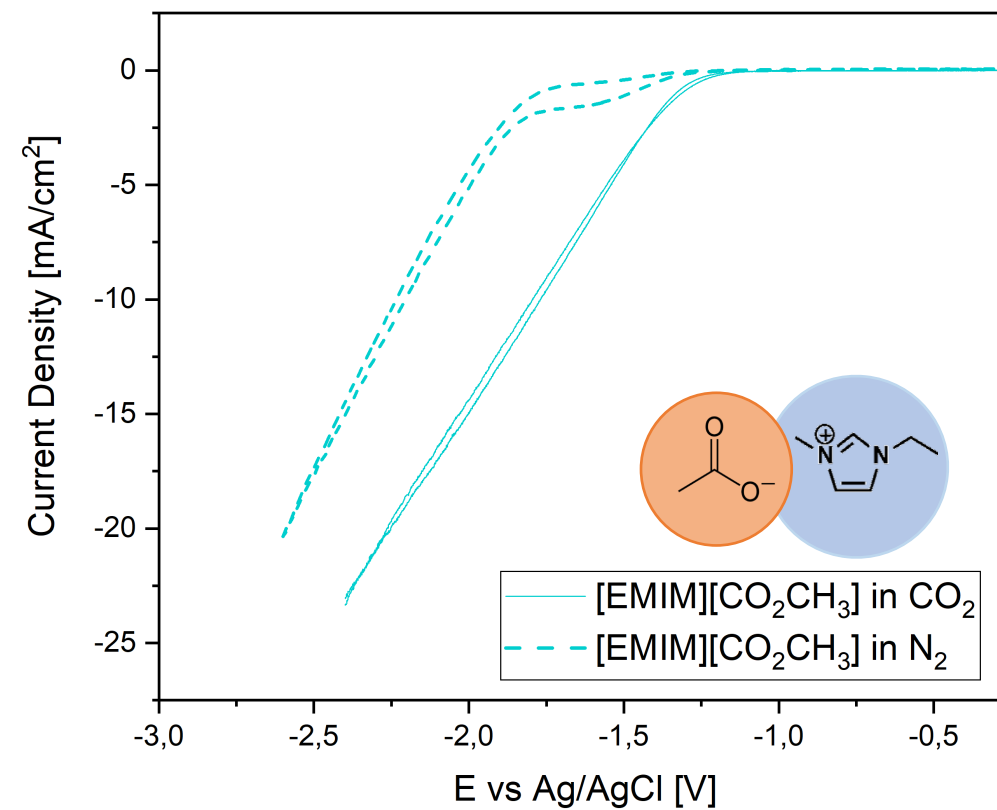


- The alkyl chain of the cation plays an **orientation role**.
- When the **alkyl chain decreases**, the imidazolium ring finds a **more convenient position** in the cathode to reduce and form the complex with the carbon dioxide molecule, which might be translated into a less negative onset potentials.⁴

Cyclic Voltammetry (CV)

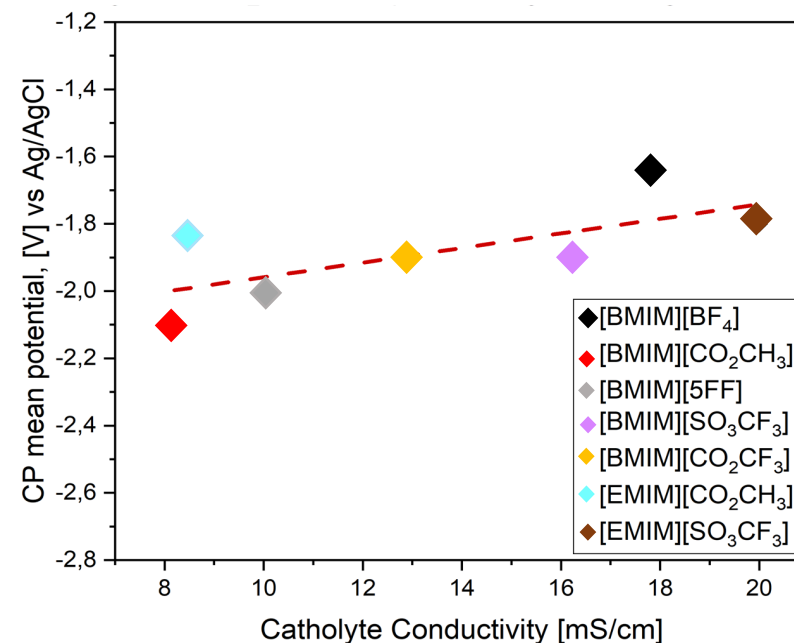
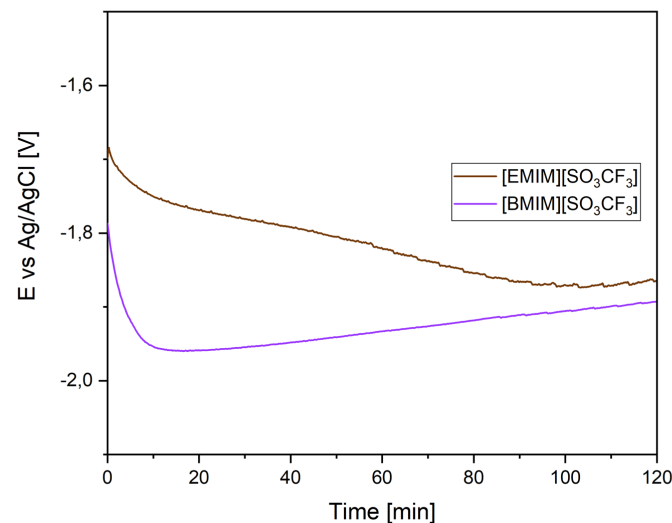
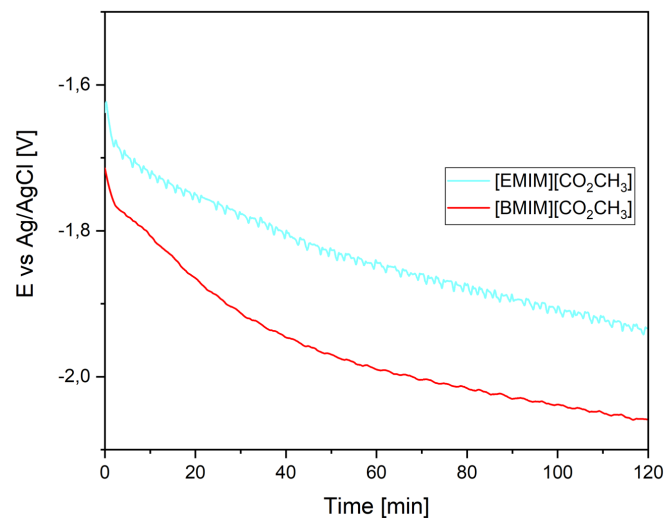


Cyclic Voltammetry (CV)



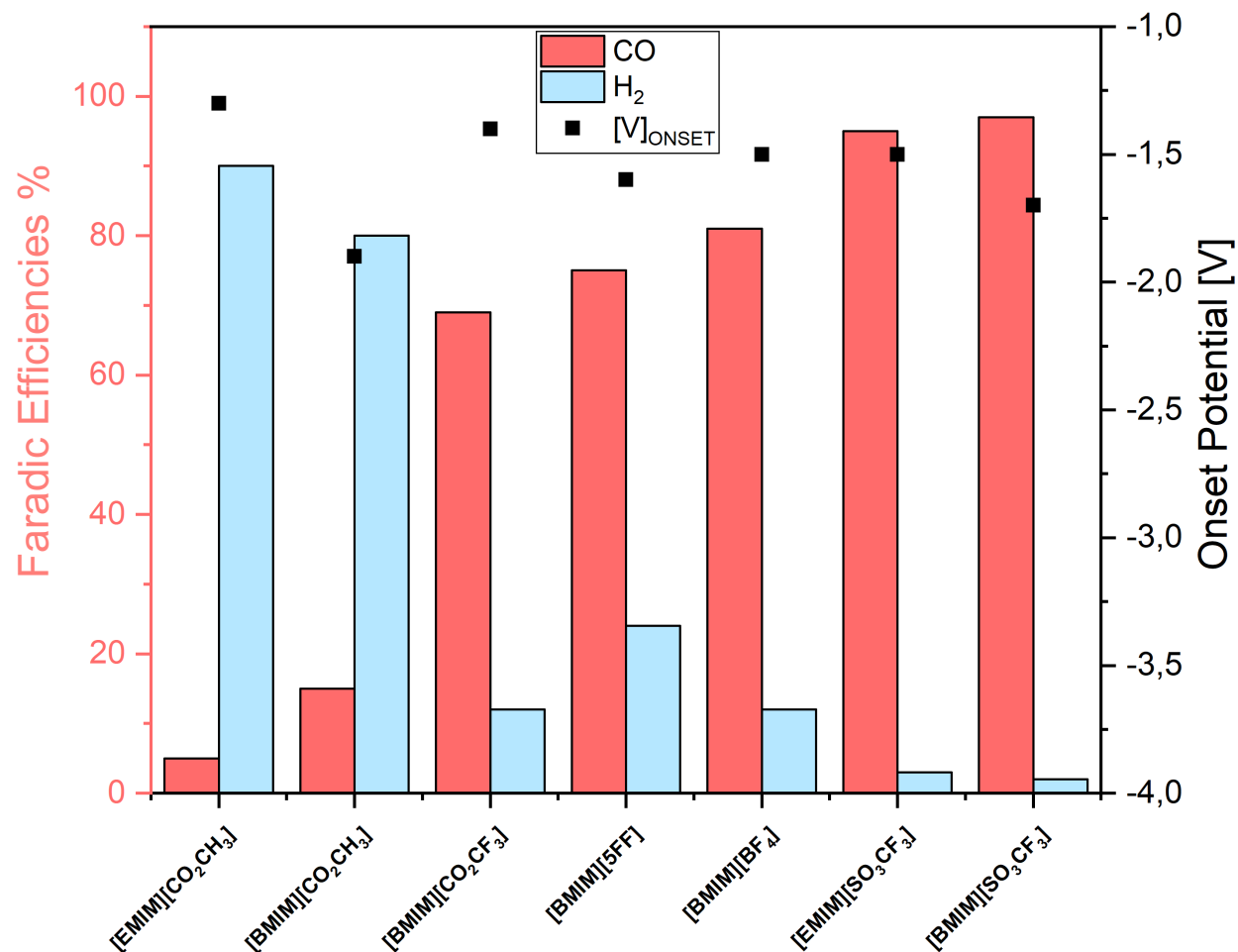
✓ **CVs' highlights:** Onset potential of all the ILs is shifted to less negative potentials when atmosphere is saturated with CO₂.

Chronopotentiometry (CP) in CO₂, t=120 min, -20 mA



✓ **CP's highlights:** comparing the CP's curves, for the same anion with EMIM cation there are fewer potentials than with BMIM. Probably this trend is due to two aspects:

- 1- A more convenient orientation reached by a shorter cation alkyl chain on the electrode surface
- 2- It can be linked to the conductivity of the catholyte. Catholyte conductivities of [EMIM][CO₂CH₃] and [EMIM][SO₃CF₃] solutions are higher than [BMIM][CO₂CH₃] and [BMIM][SO₃CF₃] respectively.

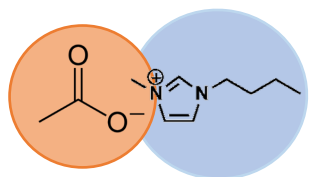
Chronopotentiometry (CP) in CO₂, t=120 min, -20 mA✓ *[V]_{Onset}'s highlights*

- Imidazolium salts of [SO₃CF₃], [BMIM][5FF] and [BMIM][CO₂CH₃] are able to decrease the overpotential for the CO₂RR to CO with respect to the most used [BMIM][BF₄].

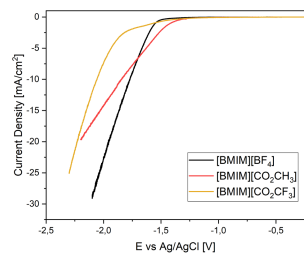
✓ *Selectivity highlights*

- The maximum FE% to CO is reached by [BMIM][SO₃CF₃].
- Ionic Liquids with acetate anion are more selective towards the production of H₂ than CO.

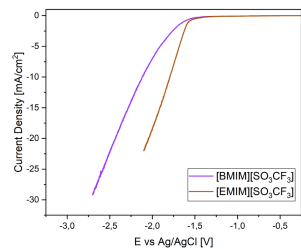
Conclusions



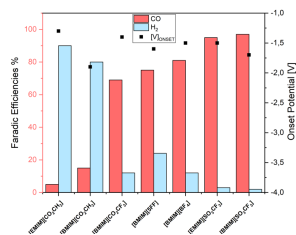
- ❖ Seven imidazolium salts were tested for the electrocatalytic CO₂ conversion to CO.



- ❖ CO₂ **solubility** depends on the **anion** of the imidazolium salt, which tends to be higher for fluorinated anions.



- ❖ The **cation** has a steric effect and an orientation role. When the **alkyl chain decreases**, the imidazolium ring finds a **more convenient position** in the cathode surface.



- ❖ Imidazolium salts of **acetate** are more selective towards the **production of H₂**. **[BMIM][SO₃CF₃]** promotes the reduction of CO₂ to CO better than the commonly used [BMIM][BF₄]. Reaction mechanisms behind these results are being studied.

Acknowledgements

*The research leading to these results has received funding from the European Union's Horizon 2020 Research and Innovation Action programme under the SunCoChem project.
(Grant Agreement No 862192)*



**Politecnico
di Torino**



Horizon2020
European Union Funding
for Research & Innovation

