Toward energy-efficient and upscalable electrohydrodynamic drying of food

Kamran Iranshahi [a], Alex Martynenko [b], Thijs Defraeye [a,b],

[a] *Empa, Laboratory for Biomimetic Membranes and Textiles, Lerchenfeldstrasse 5, 9014 St. Gallen, Switzerland*

[b] *Department of Engineering, Dalhousie University, Agricultural Campus PO Box 550 Truro, Canada*

Empa Materials Science and Technology

DALHOUSIE UNIVERSITY

Introduction

- In Electrohydrodynamic (EHD) drying, dehydration is induced by invoking ionic wind via a high voltage discharge between two electrodes:
- Non-thermal drying → Heat sensitive materials ✓
- Faster drying
- Better quality: Nutritional content ↑, Color and flavor ↑
- Low energy consumption

Objectives and Approaches

- Toward upscaling → The impact of various mesh collector parameters (e.g. mesh porosity, wire diameter)
- Toward optimization → Steps
  - 1- Gaining more insights into underlying physics **by simulation**,
  - 2- Energy analysis,
  - 3- Exergy analysis; How far is the system from ideal condition?
  - 4- Optimization; tradeoff between drying time and energy consumption.

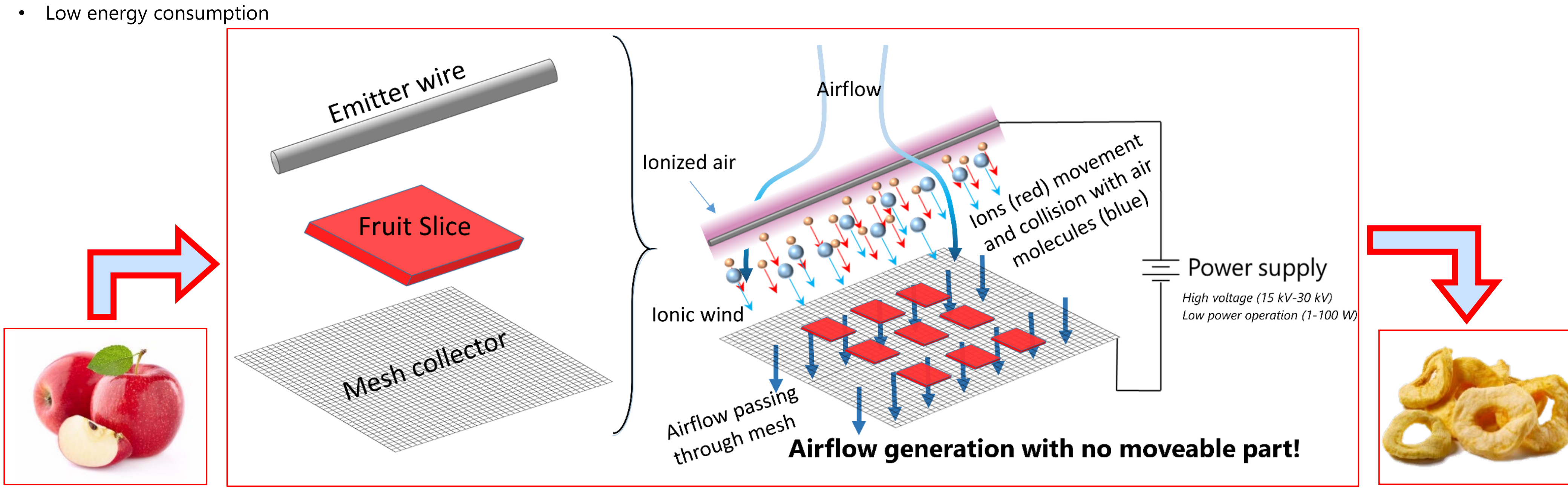
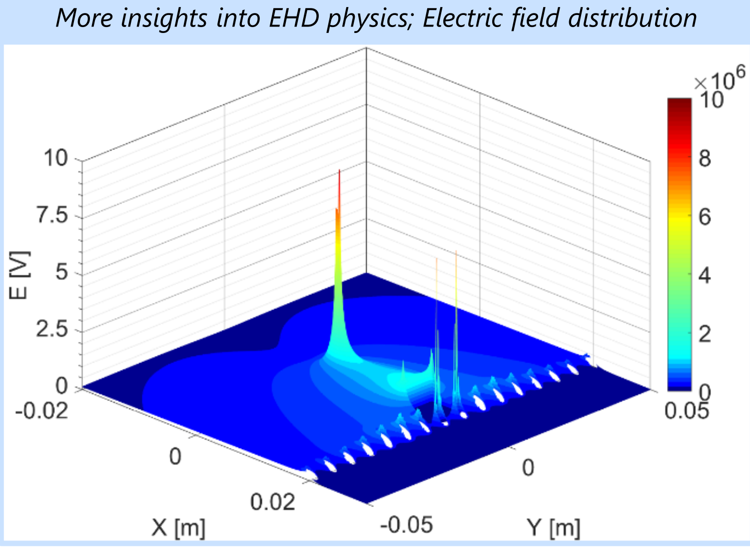


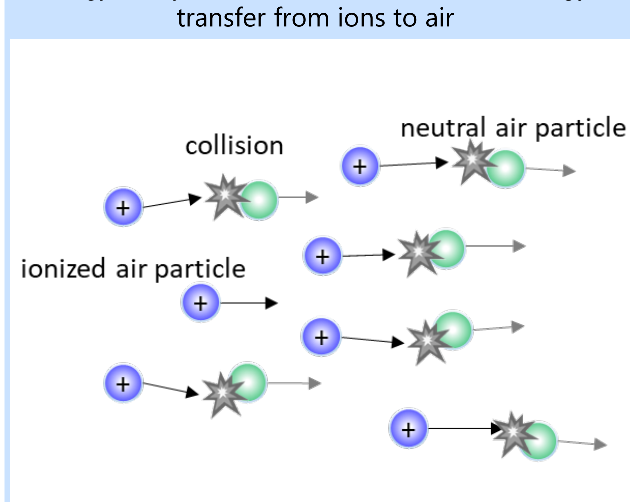
Figure 1. *Schematic of EHD dryer; Wire to mesh configuration which enables uniform drying of each product*

Results

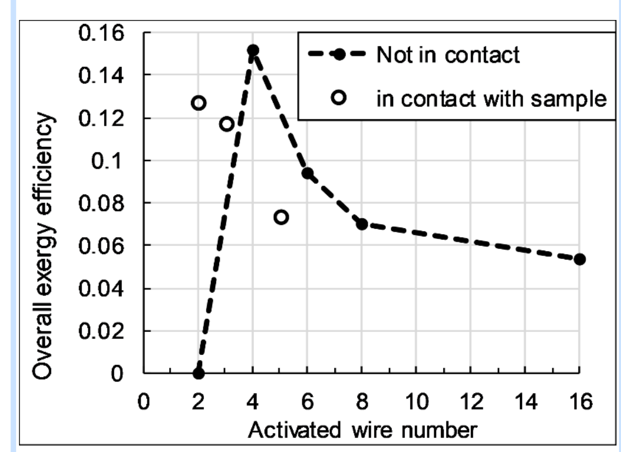
More insights into EHD physics; Electric field distribution



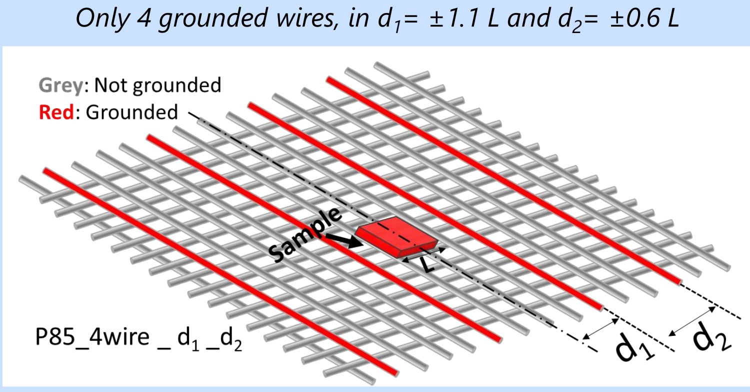
Exergy Analysis; Main source of losses → Energy transfer from ions to air



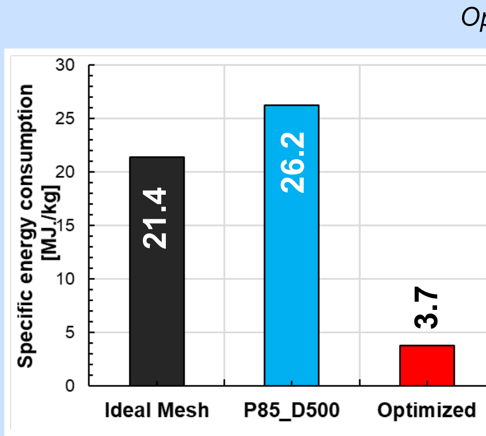
Exergy Analysis; Finding optimum number and location of grounded wires to decrease the losses



Only 4 grounded wires, in d_1= ±1.1 L and d_2= ±0.6 L

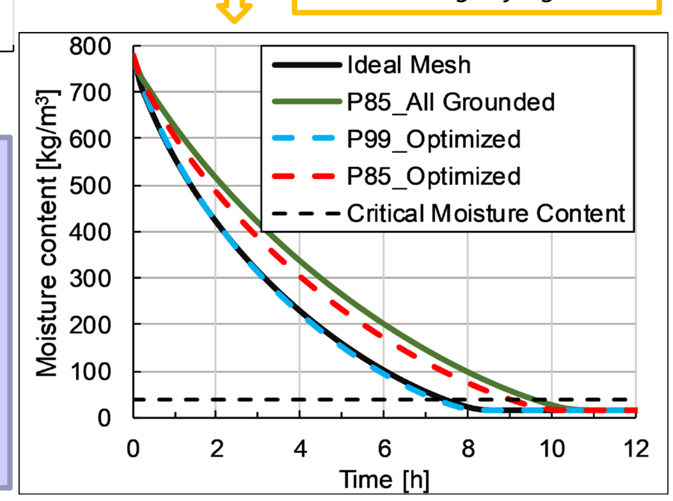


Optimization Results



Energy consumption per unit mass of fresh fruit

Moisture content of fruit slice during drying time



Compared to the not-optimized configuration, 6.4 times higher energy efficiency for the same drying time!

SDGs Relevance

Research Achievements	SUSTAINABLE DEVELOPMENT GOALS
Better dried food quality	2, 3
6.4 times higher energy efficiency	7, 13
Up-scalable configuration	9

Contact: **kamran.iranshahi@empa.ch**
thijs.defraeye@empa.ch