



Ferroelectrics for multi-energy harvesting

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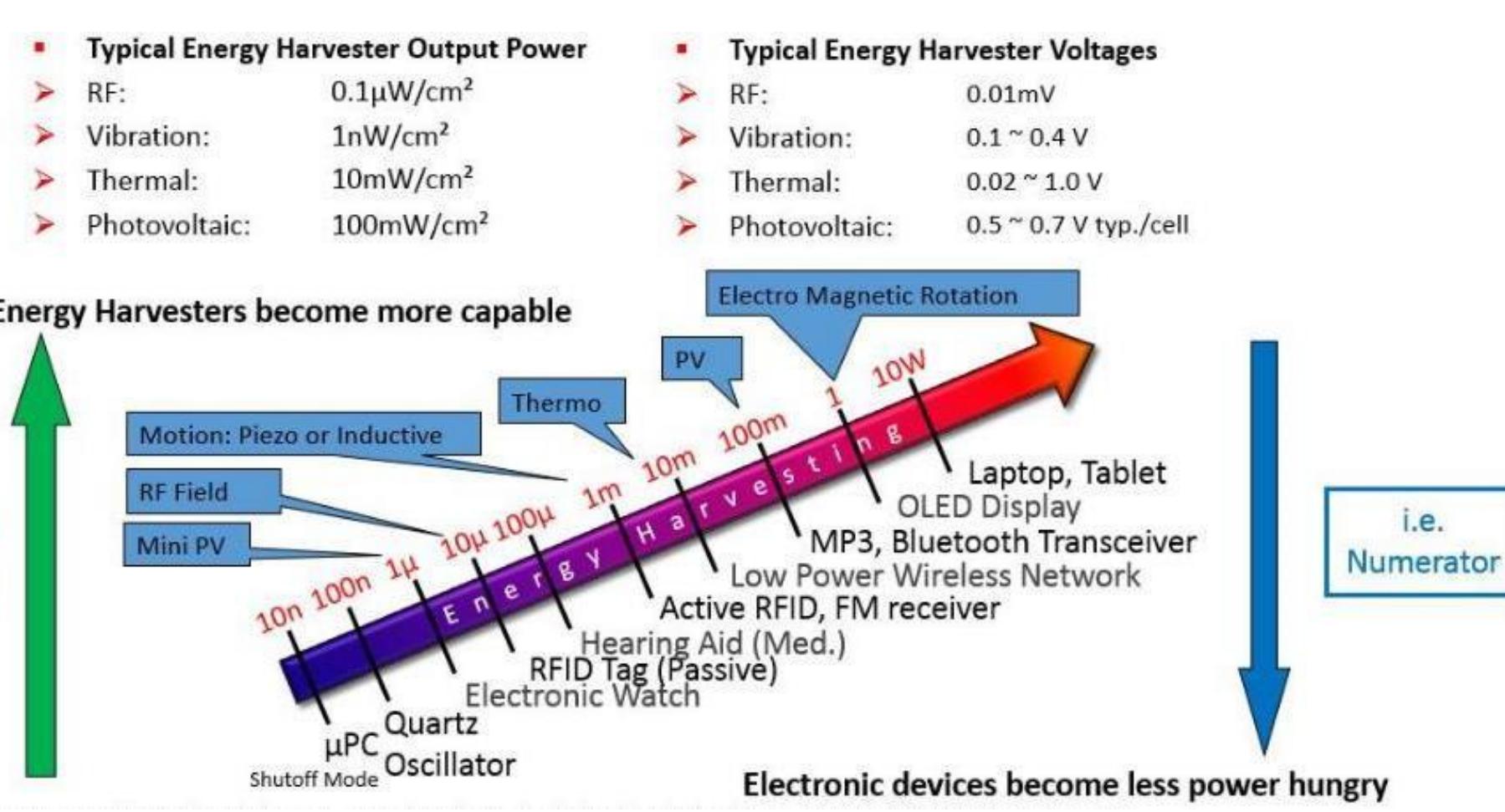
Context/Introduction

Available energy in the environment



- A lot of free energy is available in the environment:
 - Wind
 - Water flows
 - Body heat
 - Exhaust heat and vibrations
 - Light
 - Human movements
 - Human and animal heat

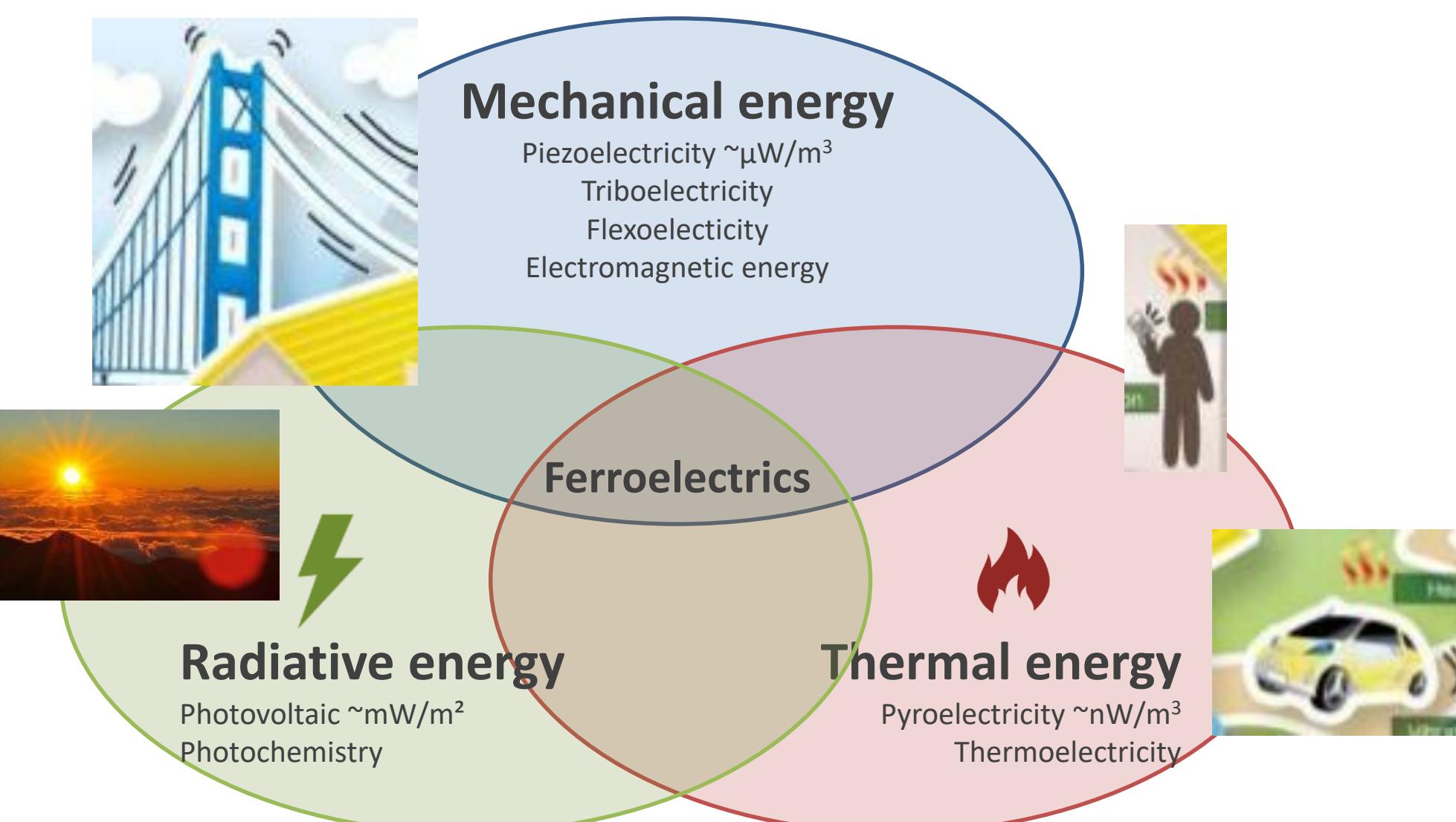
Power generation and consumption¹



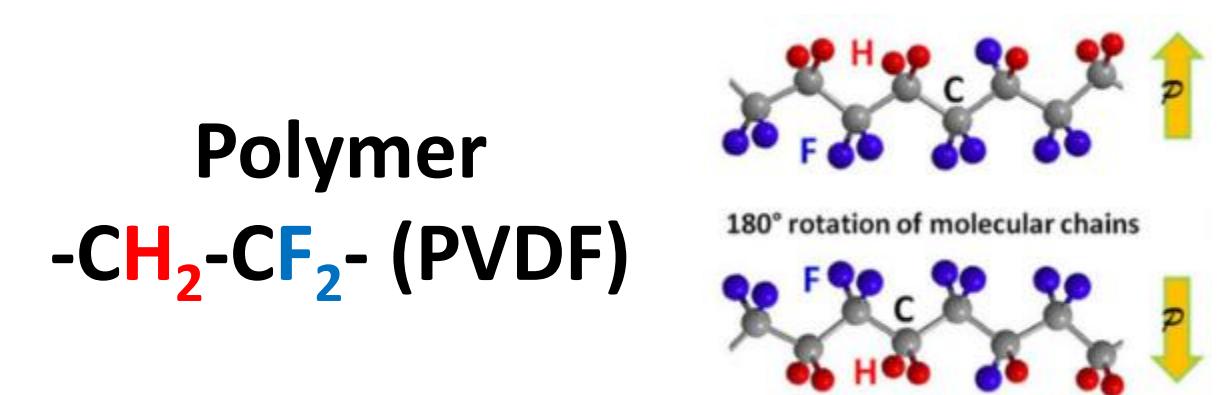
Energy consumption of sensors and small actuators are now in the same range as the energy available through energy harvesting methods.

Interest of ferroelectrics

Energy conversion methods



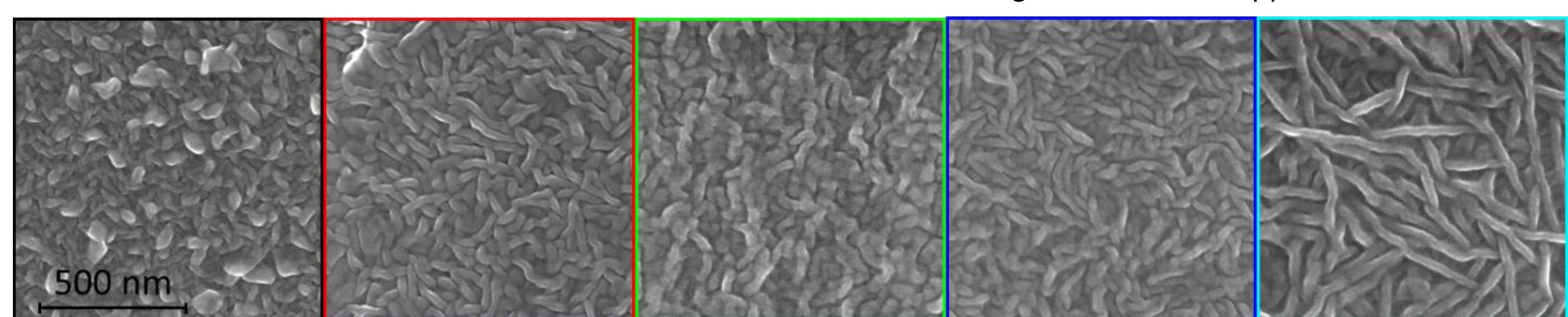
PVDF-based polymers²



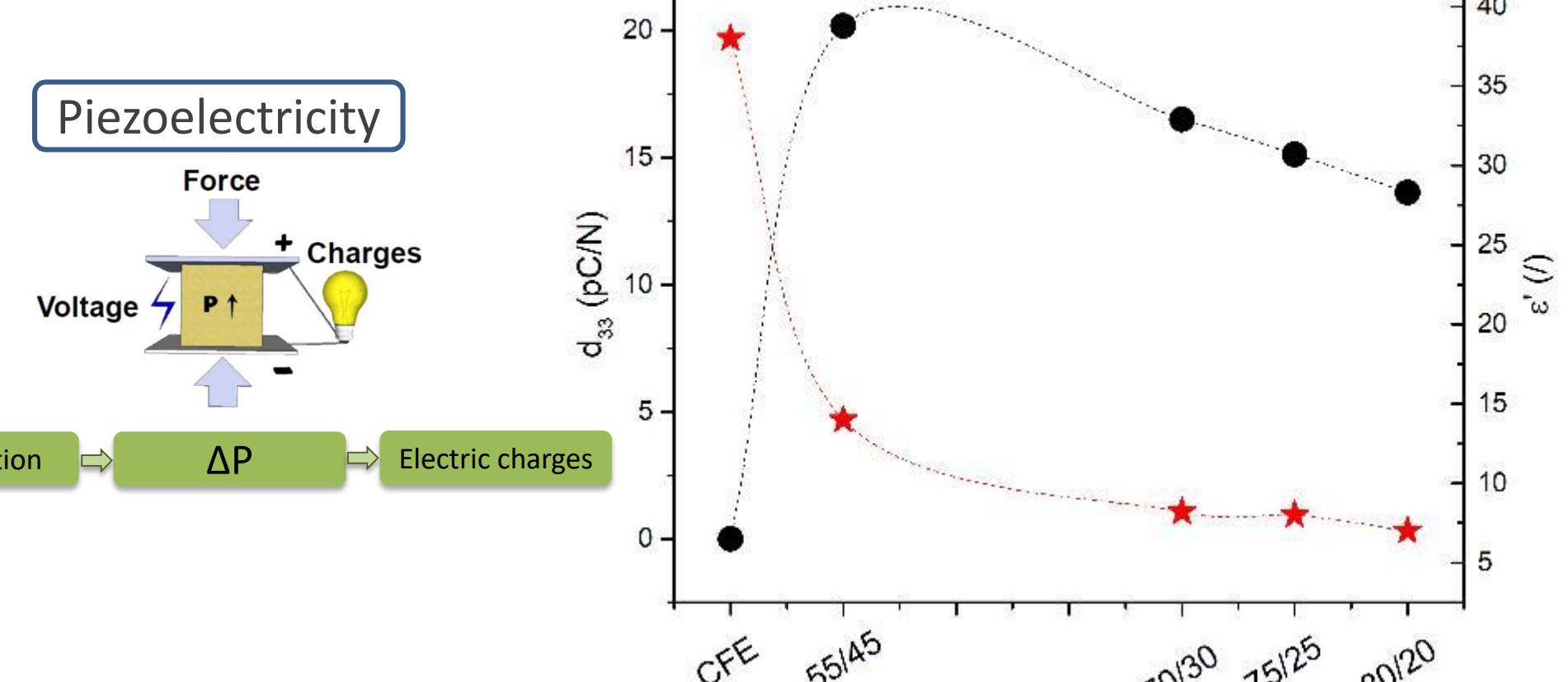
Compositions

Notation	VDF (wt %)	TrFE (wt %)	CFE (wt %)
80/20	79.6	20.4	/
75/25	75.1	24.9	/
70/30	70	30	/
55/45	54.5	45.5	/
CFE	64.6	26.2	9.2

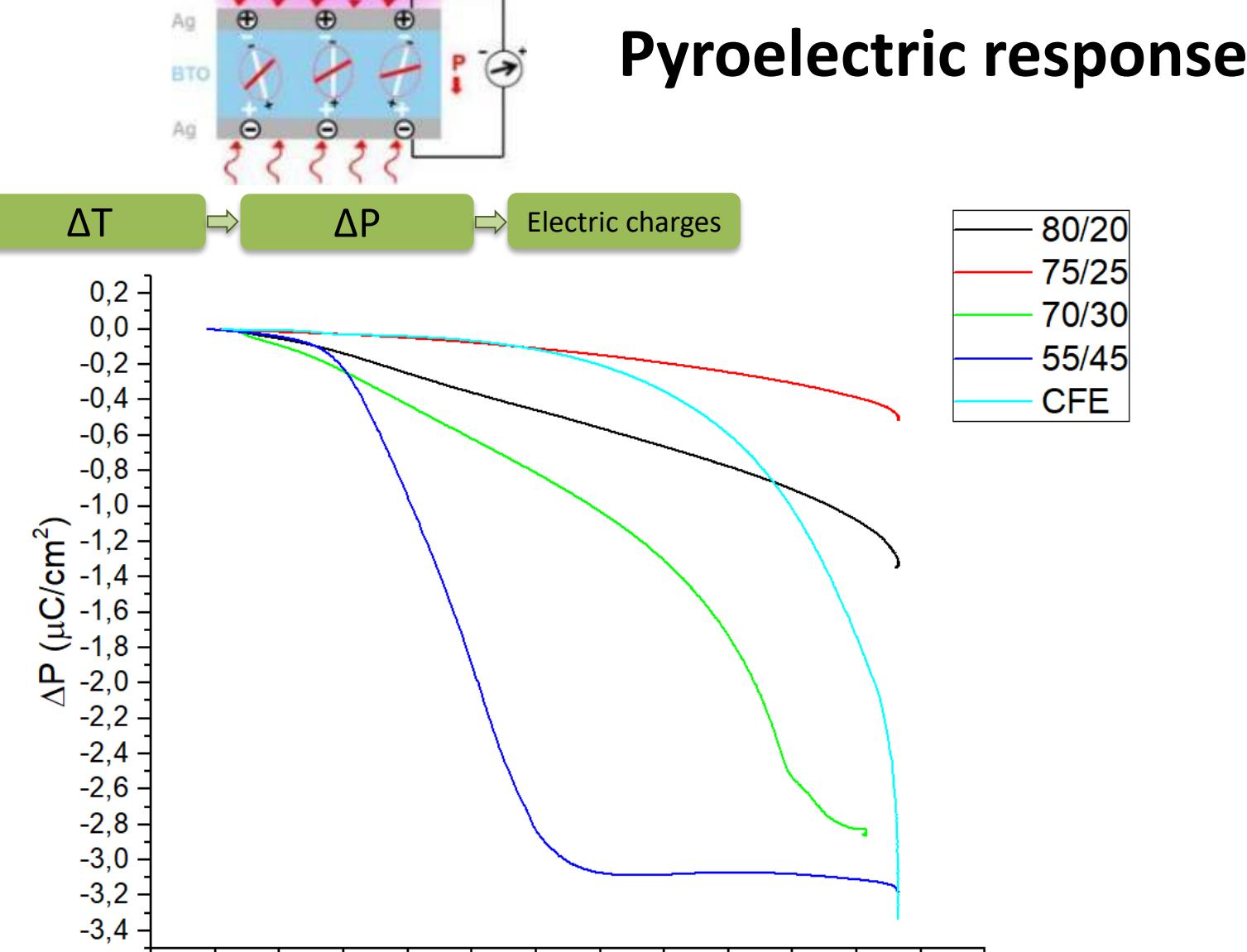
Poly(Vinylidene Fluoride): PVDF
TriFluoroEthylene: TrFE
1,1-ChloroFluoroEthylene: CFE



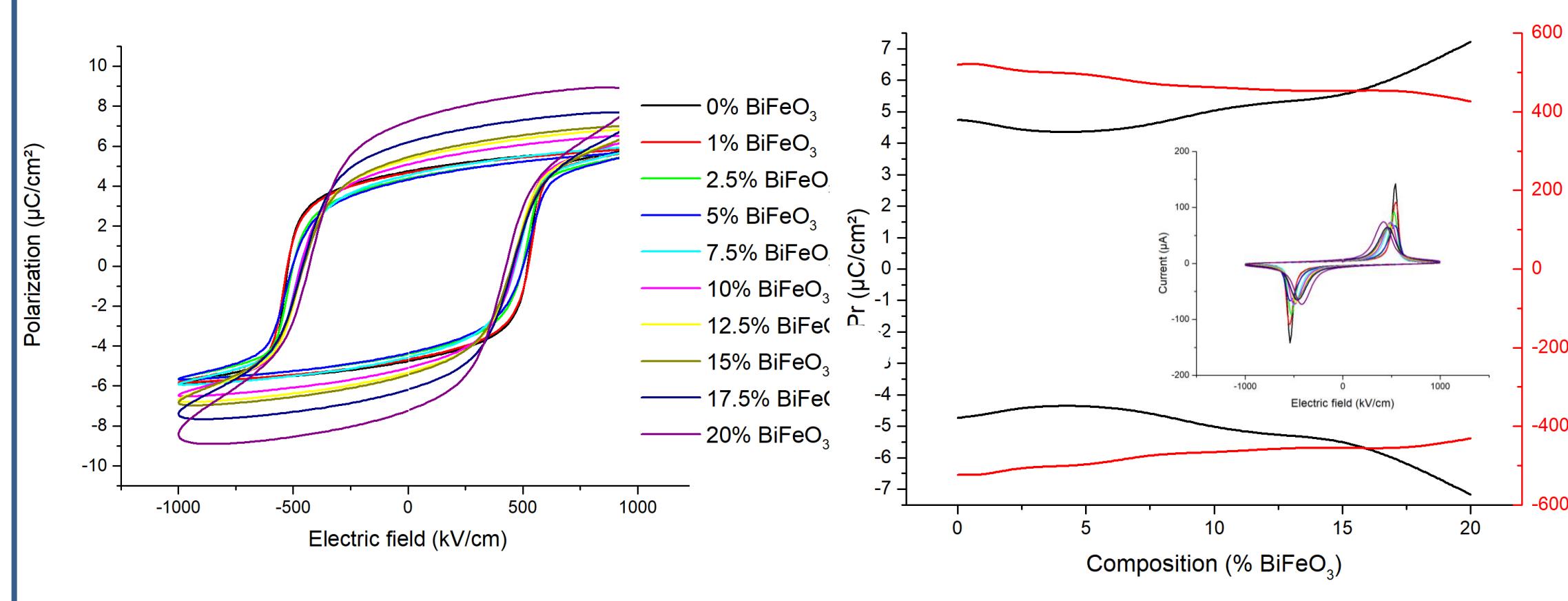
Piezoelectric response



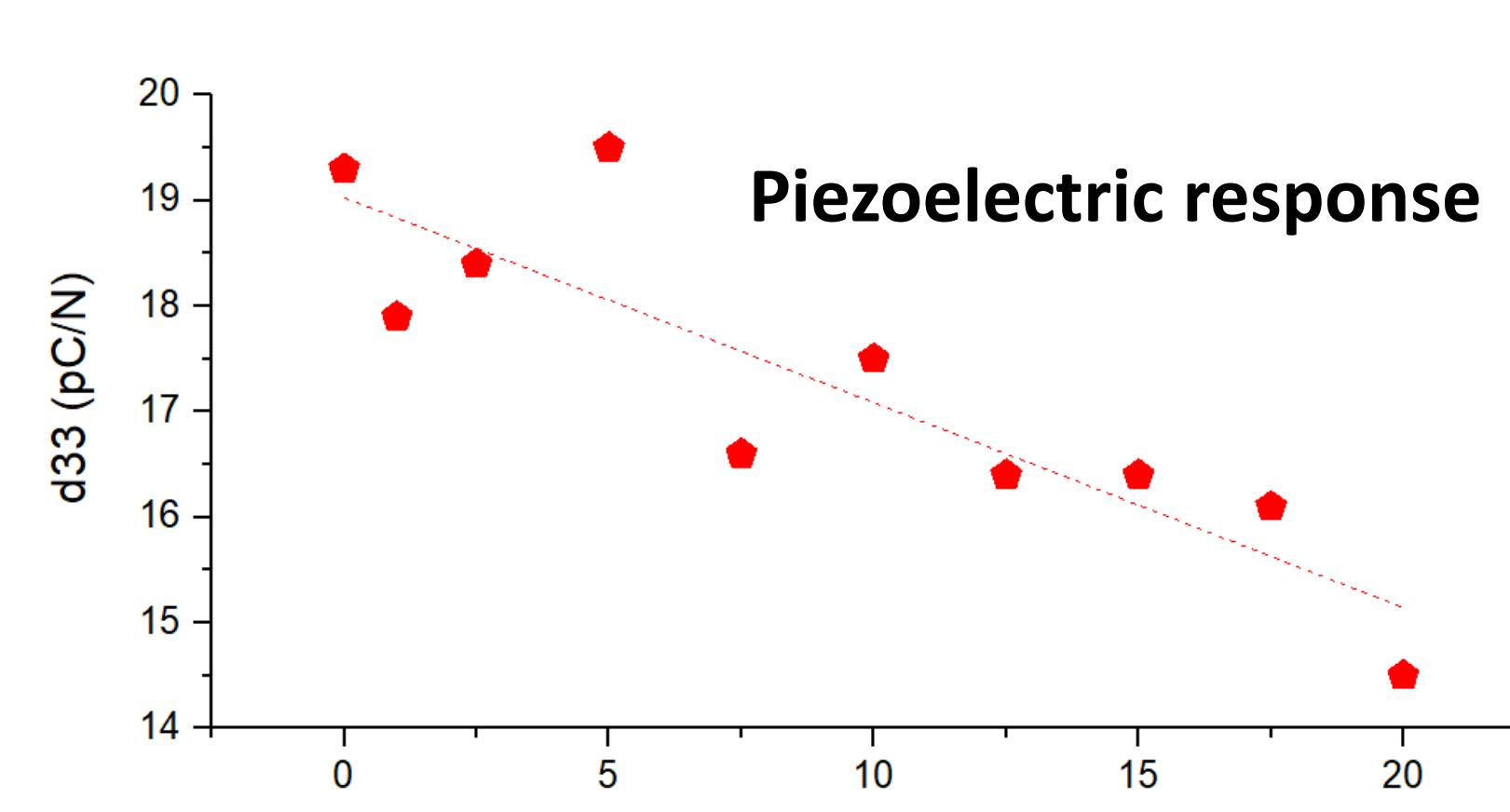
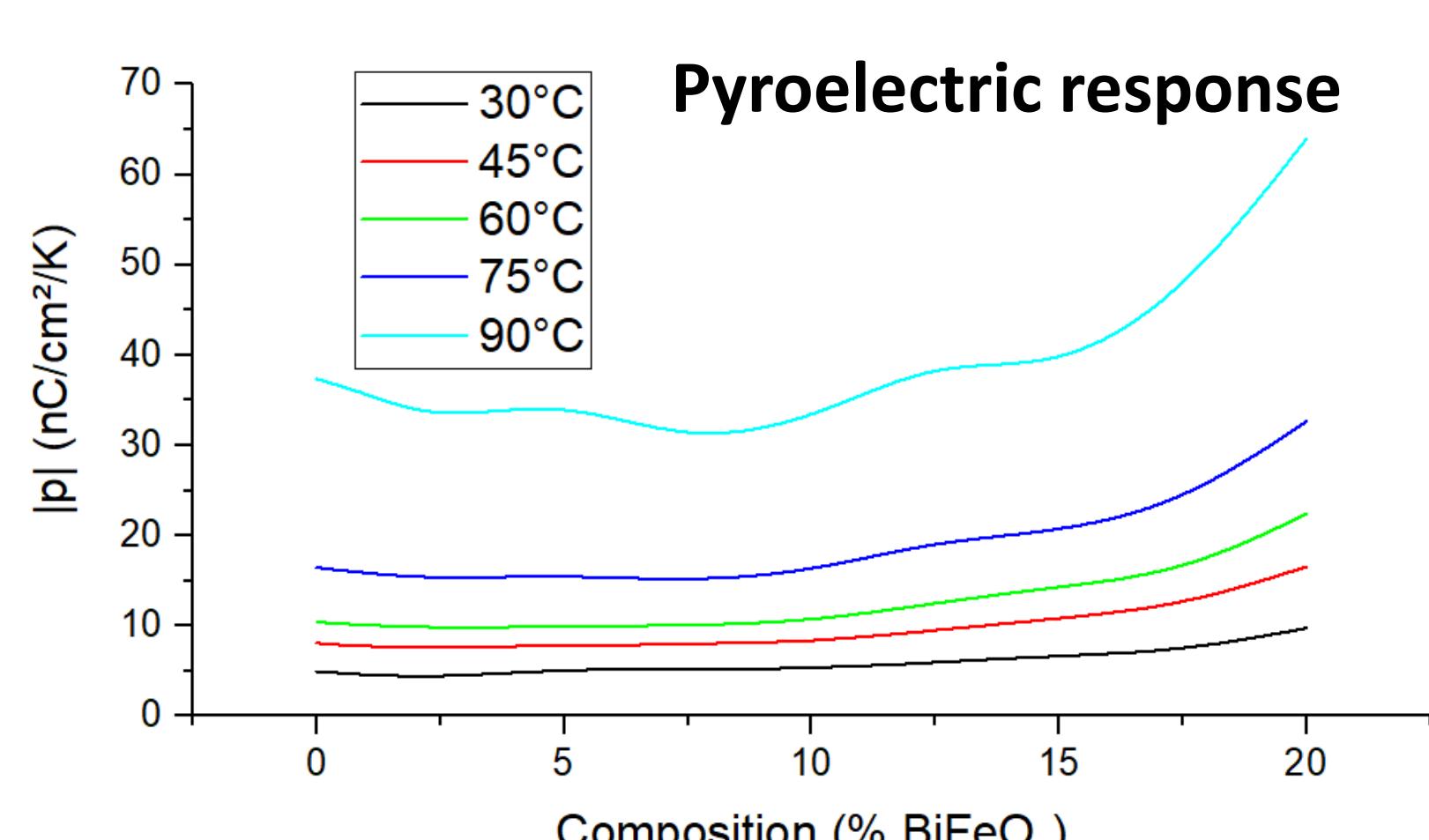
Pyroelectric response



Pyroelectric response



Pyroelectric response



Work in progress

- We have identified at least three ways we can use sequentially or simultaneously to harvest energy with ferroelectrics: **piezoelectricity, pyroelectricity and triboelectricity**.
- We have fabricated various systems (PVDF-based polymers, oxide-polymer-based composites, etc.) and studied their **functional properties**.

References

- [1] M. Hayes, "Synergies between energy harvesting and power electronics, Tyndall National Institute, IEEE PELS Young professionals webinar, Oct. 20, 2016
- [2] M. Fricaudet et al., submitted
- [3] M. Fricaudet et al., to be published