

Materials development for solar thermoelectric power generators

Rosa Robert, Sara Romer, Sylvie Hebert, Antoine Maignan, M. Trottmann, Anke Weidenkaff

Introduction

The increasing demand on energy worldwide requires the use of new energy sources. The utilisation of solar radiation as energy source is a clean way to generate electrical power.

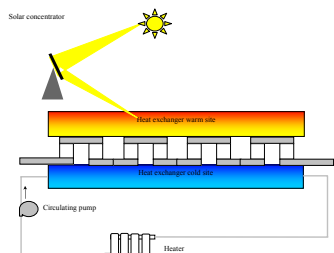


Figure 1. Thermoelectric diagram for solar power generators.

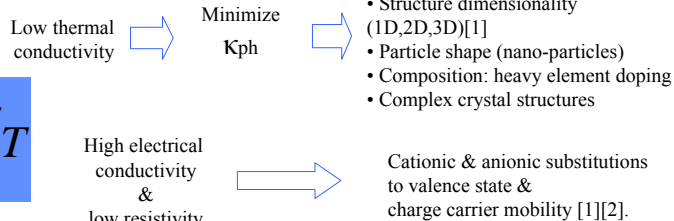
The direct conversion of solar heat into electricity requires materials exhibiting:

- large electrical conductivity
- large Seebeck coefficient
- small thermal conductivity
- high thermal and chemical stability at high temperature

$$ZT = \frac{S^2 \sigma}{\kappa} T$$

Materials

Perovskite-type oxides are potential candidates for thermoelectric devices operating at high temperatures ($400 \text{ K} < T < 1000 \text{ K}$) due to their high stability at high temperatures in air.



Methods

Fine-powders by polymeric method

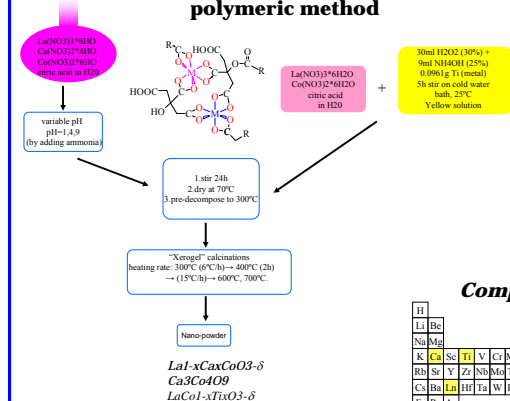


Figure 2. Flowchart for the preparation of perovskite-type oxides by polymeric method.

Tuning of Perovskite-type oxides properties

Soft Chemistry methods

Composition

H	He																
Li	Be	B	C	N	O	F	Ne										
Na	Mg	Al	Si	P	S	Cl	Ar										
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	J	Xe
Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
Fr	Ra	Ac															

Morphology nano-scale materials

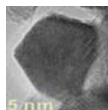
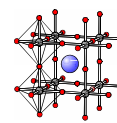


Figure 4. TEM of $La_{1-x}Ca_xCoO_{3-\delta}$

Crystal Structure



Fine-powders & thin films by Ultrasonic Spray-pyrolysis

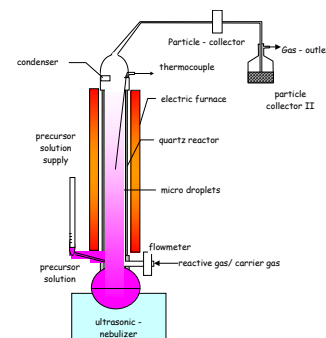


Figure 5. Soft-chemistry aerosol process [3].

First Results

Characterization

- Structure: XRD
- Composition: SEM/EDX, XRF, ICP-OES
- Precursors decomposition: Raman, TGA

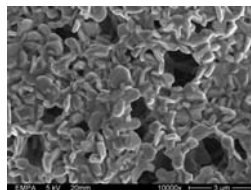


Figure 6. SEM of $Ca_3Co_4O_9$ product.

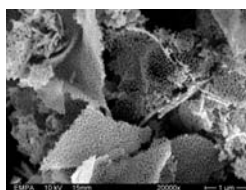


Figure 8. SEM of $LaCoO_{3-\delta}$ product.

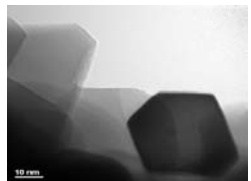


Figure 7. TEM of $Ca_3Co_4O_9$ product.

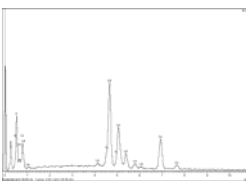


Figure 9. SEM/EDX of $LaCo_{1-x}Ti_xO_{3-\delta}$

Thermopower measurements at $300 \text{ K} < T < 600 \text{ K}$

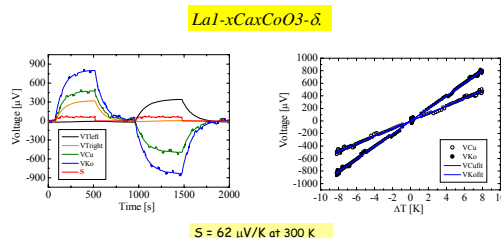


Figure 10. Set-up for thermoelectric measurements at high temperature* [4].

Thermopower measurements at $1 \text{ K} < T < 300 \text{ K}$

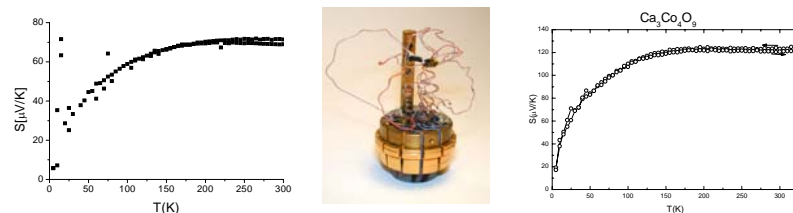


Figure 11. Set-up for thermoelectric measurements at low temperature.

Literature

- [1] S. Hébert, D. Flahaut, D. Pelloquin, C. Martin, A. Maignan, 22nd International Conference on Thermoelectrics 2003.
- [2] R. Robert, M. Trottmann, A. Weidenkaff. To be published.
- [3] Structure - Property Relation of Perovskite-type Cobaltates, A. Weidenkaff, A. Maignan, B. Raveau, A. Reller, 9th European Conference on Solid State Chemistry, Stuttgart, 2003.
- [4] Set-up based on Stölzer *et al.*, 4th Workshop on Thermoelectrics (1998). *A. Jacquot.

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