Personal project of research

Analysis and applications of zinc oxide in piezoelectric batteries

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Made by MENAI Sofia L1 SI

Presentation of zinc oxide

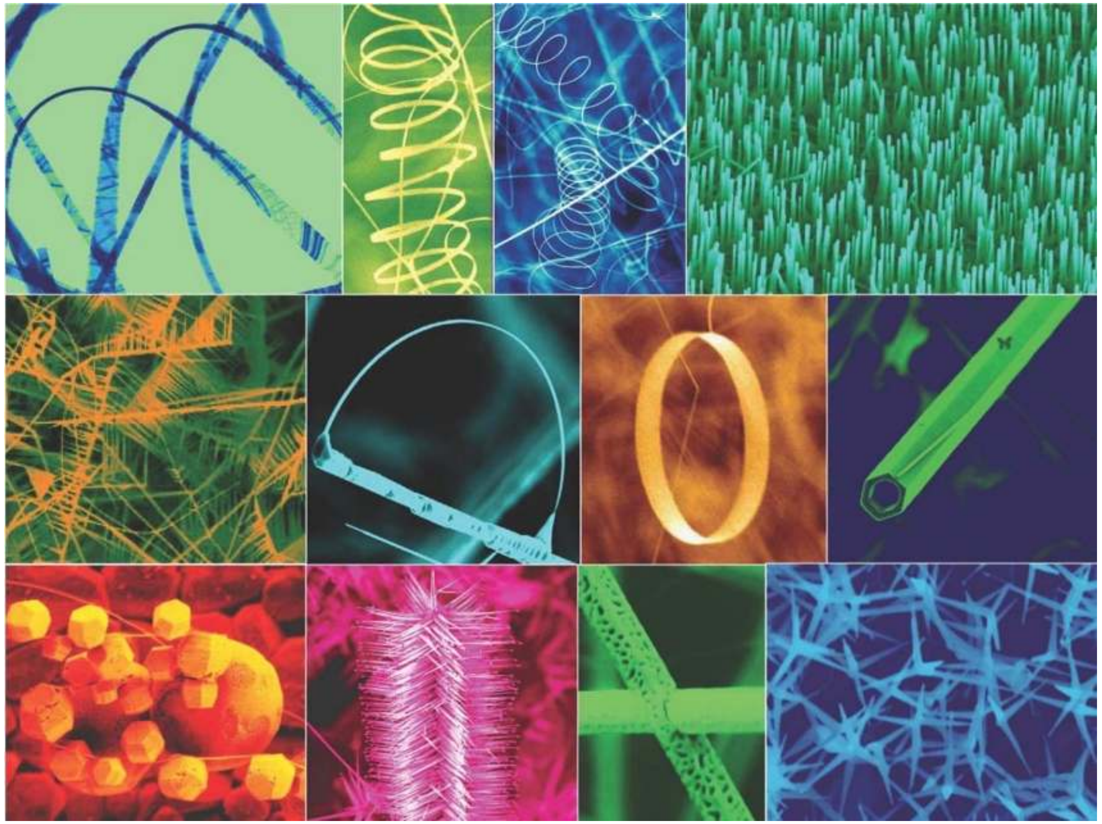


Fig 1. A collection of nanostructures of ZnO synthesized, Zhong Lin Wang, June 2004

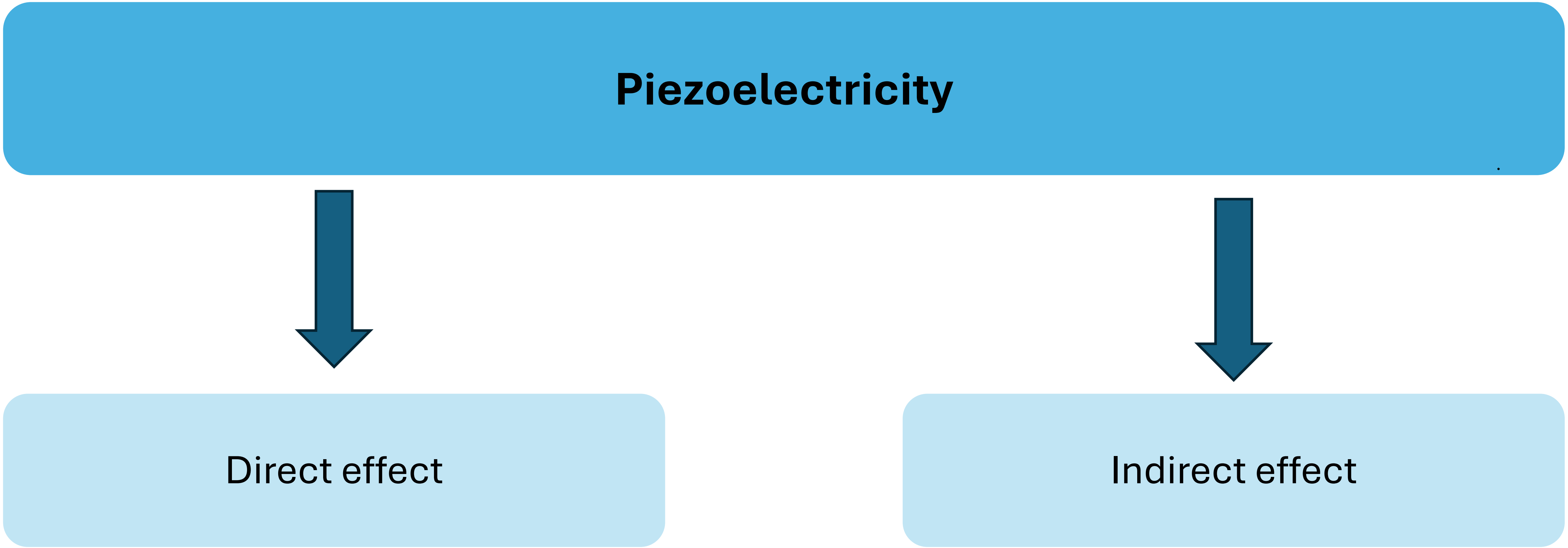
Semiconductivity

Photoluminescence

Antibacterial properties

Piezoelectricity

Piezoelectricity



when a piezoelectric material generates an electrical charge under mechanical pressure

When a current is applied, there is a mechanical, sound, or other response.

Fig 2. Piezoelectric effects

Applications for the piezoelectric

Fig 3. « Offshore wind power: 4 questions on these divisive projects », Echos, 24/06/2023

Fig 4. « This London street uses passers-by to generate electricity », BFM, 25/07/2017

Pressure sensors

Vibration cancellation devices

Offshore wind turbines

Sidewalks

Piezoelectric energy batteries

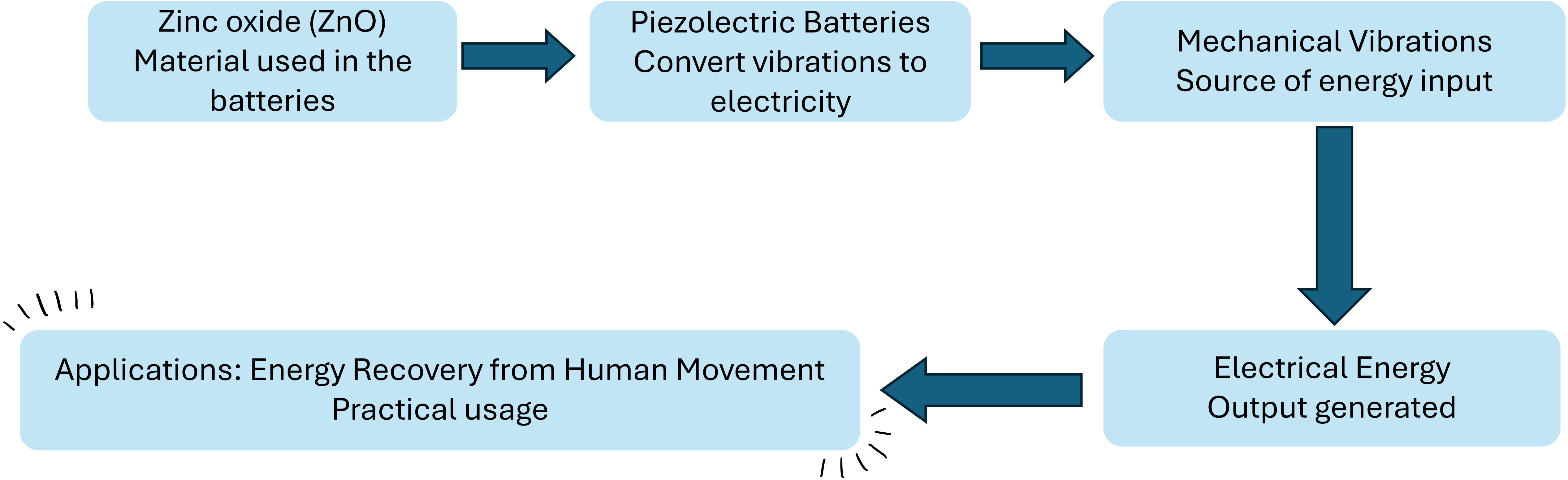


Fig 5. Piezoelectric batteries functioning

formula and explanations

This is a second-order equation with second member here: $\frac{d^2x}{dt^2} + \frac{k}{m}x = F_{\text{ext}}$

with sinusoidal force, of the form $F = F_0 \cos(\omega t)$

The solution type to this differential equation is: $x(t) = A\cos(\omega t + \varphi)$

So we replace $x(t)$ **in this formula:** $\frac{d^2x}{dt^2} = -A\omega^2 \cos(\omega t + \varphi)$

We obtain: $-A\omega^2 \cos(\omega t + \varphi) + \left(\frac{k}{m}\right) A\cos(\omega t + \varphi) = \left(\frac{F_0}{m}\right) \cos(\omega t)$

Here, the equation becomes:

$$\cos(\omega t)\left(-A\omega^2 + A\left(\frac{k}{m}\right)\cos(\varphi) - \frac{F_0}{m}\right) - \sin(\omega t)\left(-A\omega^2 + A\left(\frac{k}{m}\right)\right)\sin(\varphi) = 0$$

We can find that the Amplitude: $A = \frac{F_0/m}{\omega_0^2 - \omega^2}$

Amplitude, resonance frequency and Tacoma bridge

- when ω gets closer to ω_0=> the amplitude increases a lot

- each material has its own resonance frequency

- a strong response when we attain this frequency

- Tacoma Bridge

- the wind caused vibrations that matched the bridge's resonance frequency.

Fig 6. "Tacoma Bridge - Mechanical resonance", Youtube, published by ElectronDZ, May 27 2009, https://youtu.be/uhWQ5zr5_xc?si=uphT4YnVZkibGAtn

The principle is to use an energy "wasted" in normal times, but which now becomes an useful source of electricity

Next year

- how to calibrate a piezoelectric on several frequencies at same time
- The environmental impact of its massive commercialization

Thank you for listening