



**CENTRUM PRO INOVACE  
V OBORU NANOMATERIÁLŮ A NANOTECHNOLOGIÍ**

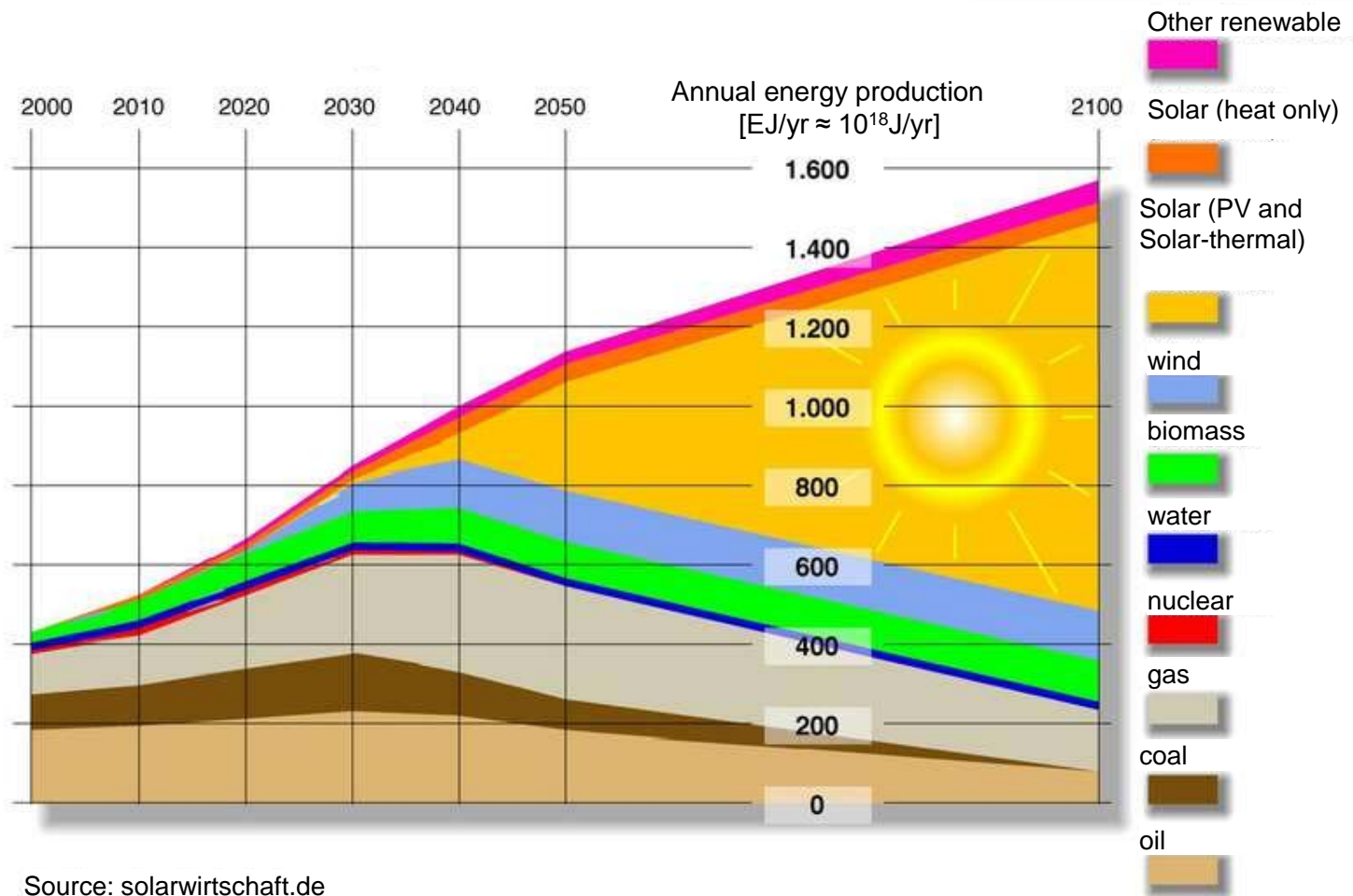


**Ladislav Kavan**

(garant pro oblast elektrodové procesy)

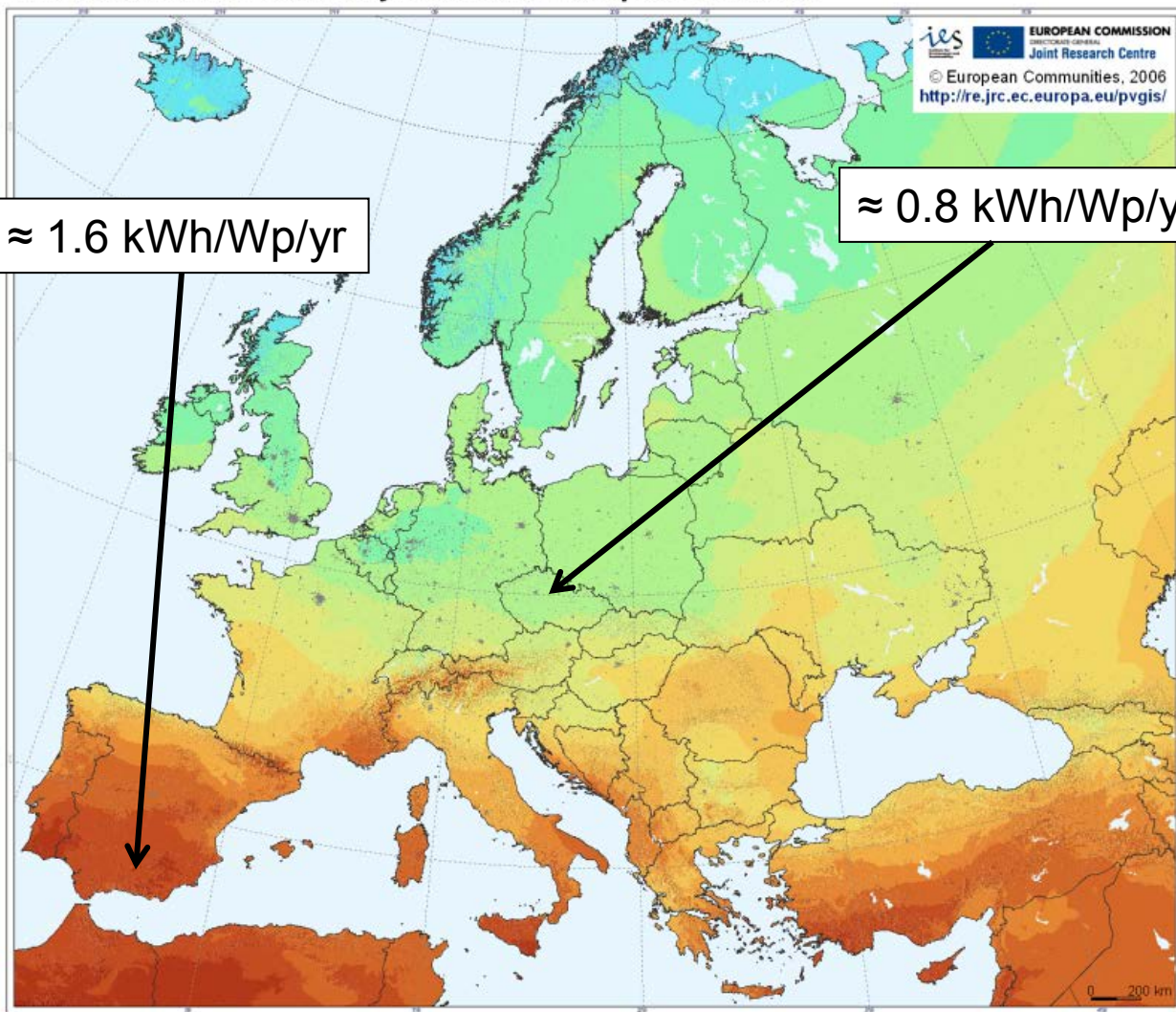
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# Global energy production by 2100



Source: solarwirtschaft.de

# Photovoltaic Solar Electricity Potential in European Countries



ies  
 EUROPEAN COMMISSION  
 Joint Research Centre  
 © European Communities, 2006  
<http://re.jrc.ec.europa.eu/pvgis/>

AM1.5 (Sun)  $P = 1 \text{ kW/m}^2$

$W_p = P \cdot \phi \cdot A$ ; ( $\phi \approx 10\%$ )

No.	Country	Wp/capita (2010)
1	Germany	212.3
2	Czech Republic	185.9
3	Spain	82.8
4	Belgium	72.6
5	Italy	57.6
6	Luxembourg	54.3
7	Slovakia	26.5
8	Greece	18.2
9	Slovenia	17.8
10	France	16.3
11	Portugal	12.3
12	Austria	12.2
13	Cyprus	7.8
14	Netherlands	5.8
15	Malta	4.0
16	Bulgaria	2.3
17	Finland	1.8
18	Denmark	1.3
19	United Kingdom	1.2
20	Sweden	1.1
21	Hungary	0.2
22	Ireland	0.1
23	Romania	0.1
24	Estonia	0.1
25	Poland	0
26	Lithuania	0
27	Latvia	0

Yearly sum of global irradiation incident on optimally-inclined south-oriented photovoltaic modules  
 Global irradiation [kWh/m<sup>2</sup>]  
 Yearly sum of solar electricity generated by 1 kWp system with optimally-inclined modules and performance ratio 0.75  
 Solar electricity [kWh/kWp]

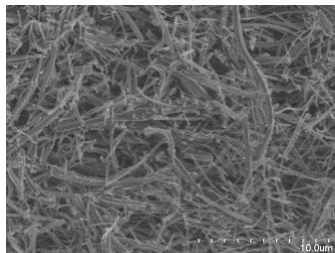
av. consumption (CZ): 1400 kWh/capita/yr  $\approx$  1750 Wp (households only)

Source: Photovoltaic energy barometer 2011 - EurObserv'ER1

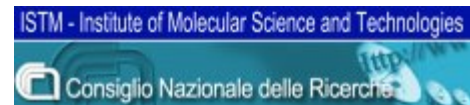


# Sensitizer Activated Nanostructured Solar Cells

2011-2013 ( 5.2 Mio €)  
<http://sans-solar.eu>



TiO<sub>2</sub> nanovlákna  
pro fotoanody solárních článků



# Energetická kapacita materiálů

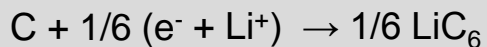
Nosič energie	kWh/kg	kWh/L
Vodík (kap. 23 K)	33	2.4
Vodík (plyn 20 MPa)	33	0.5
Benzín	13	9
Pb-baterie	0.03	0.09
Li-baterie	0.2	0.5
Superkondenzátor	0.005	0.01

Aplikace nanomateriálů v (elektrochemické) akumulaci energie:  
*superkondenzátory, baterie, palivové články*



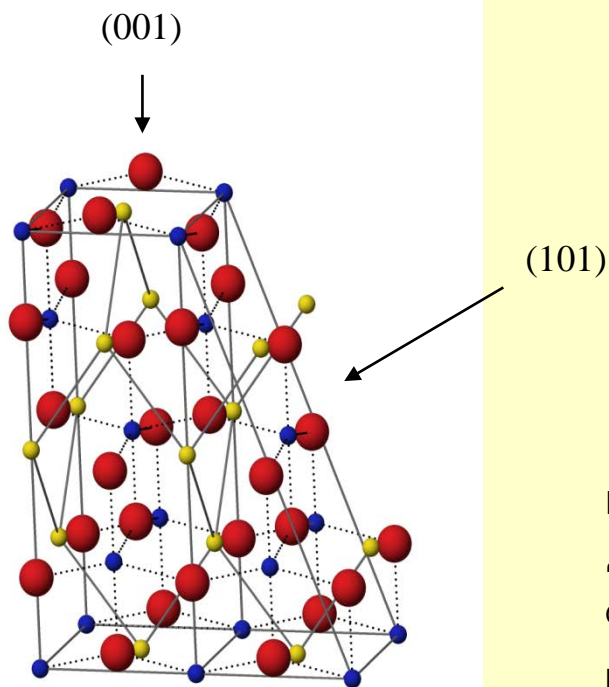
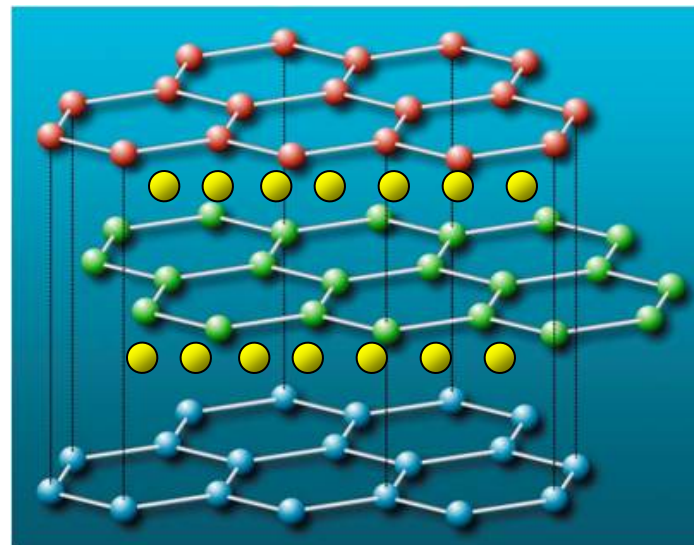
# ● Li<sup>+</sup>

## Grafit interkalace:

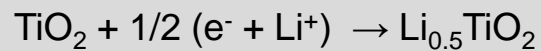


$$E_{\text{form}} \approx 0.2 \text{ V vs. Li/Li}^+$$

$$Q_{\text{spec}} = 1340 \text{ C/g} = 372 \text{ mAh/g}$$



## TiO<sub>2</sub> (anatase) inserce:



$$E_{\text{form}} \approx 1.85 \text{ V vs. Li/Li}^+$$

$$Q_{\text{spec}} = 168 \text{ mAh/g}$$

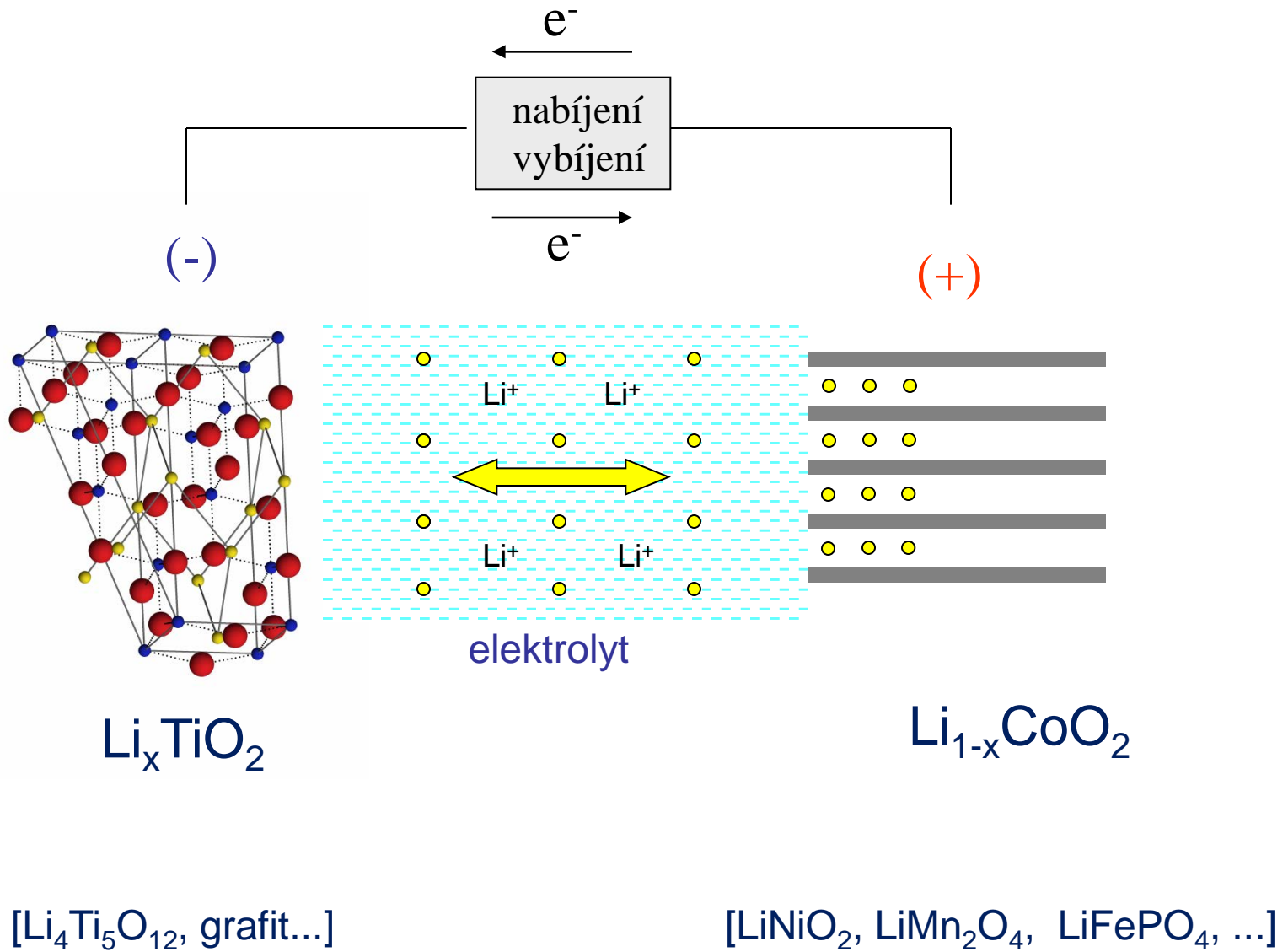
IUPAC definice:

**“Intercalation”** = non covalent inclusion into **laminar hosts**

G. P. Moss, P. A. S. Smith, D. Tavernier, *Pure Appl. Chem.* **1995**, 67, 1307-1375

Lat.: *mensis intercalarius* (Julianská/Gregoriánská reforma kalendáře, 46 BC)

# Baterie Li-ion



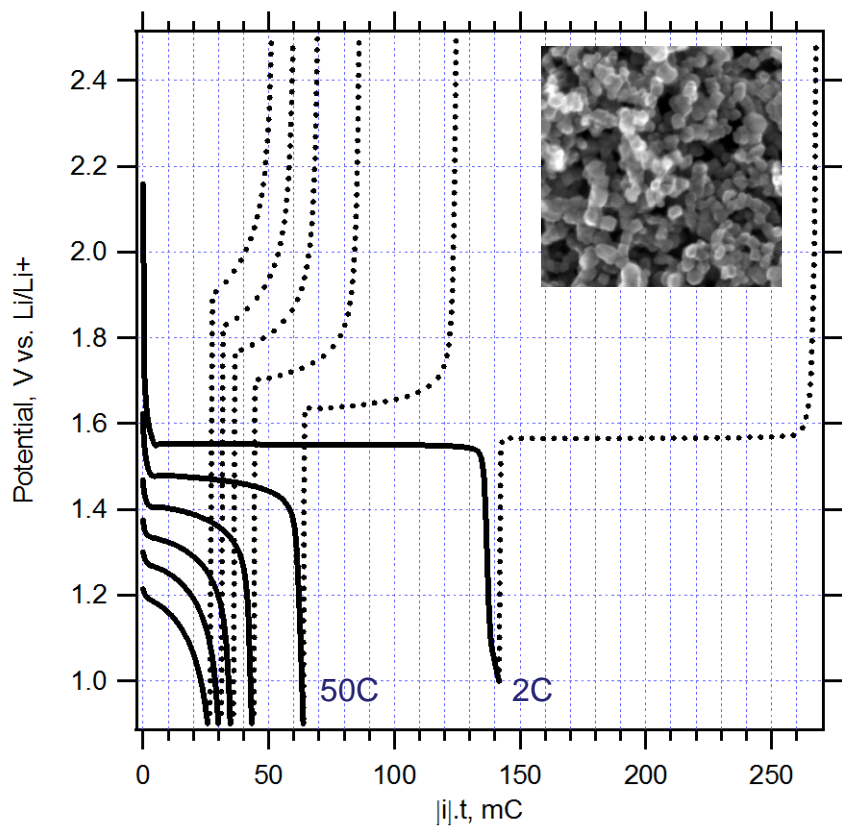


# Li<sub>4</sub>Ti<sub>5</sub>O<sub>12</sub> (spinel): galvanostatické

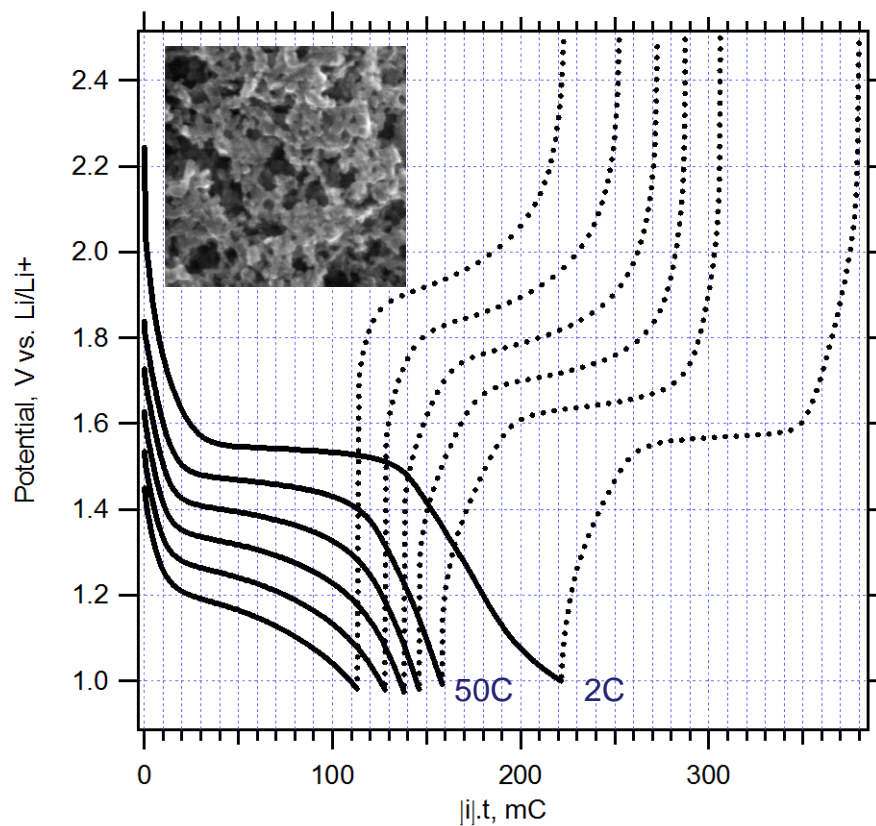
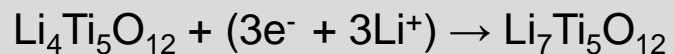
## nabíjení/vybíjení

Rychlost:

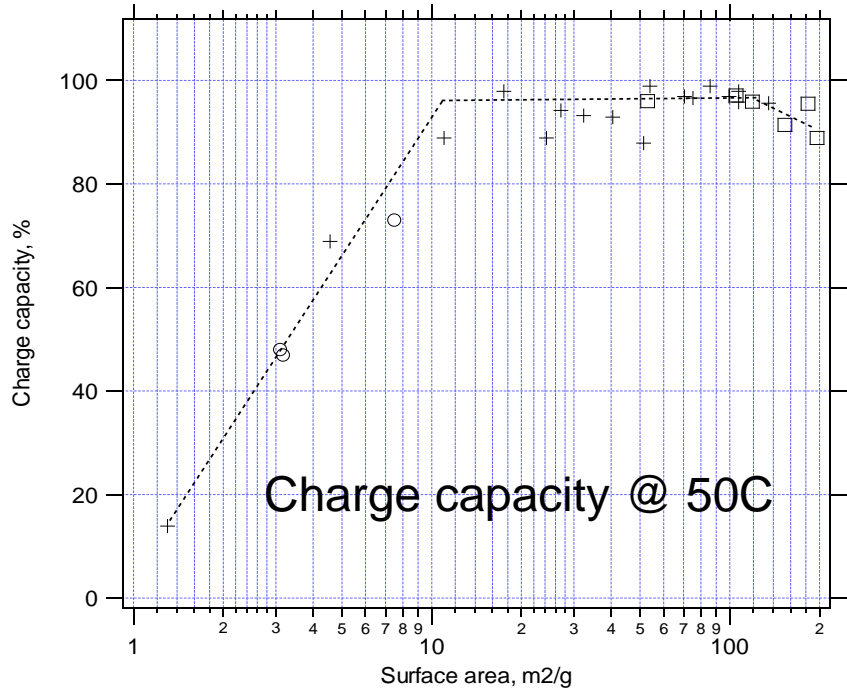
2C, 50C, 100C, 150C, 200C, 250C



• Komerční materiál (∅ ≈ 1 μm)



• nanomateriál (∅ ≈ 10 nm)



135m<sup>2</sup>/g

107m<sup>2</sup>/g

100 m<sup>2</sup>/g

70 m<sup>2</sup>/g

50 m<sup>2</sup>/g

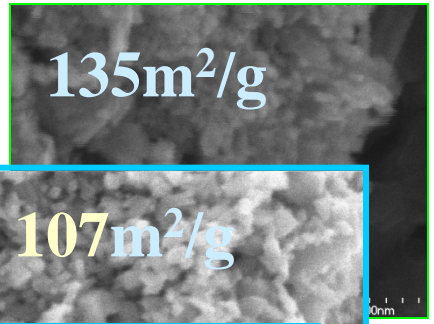
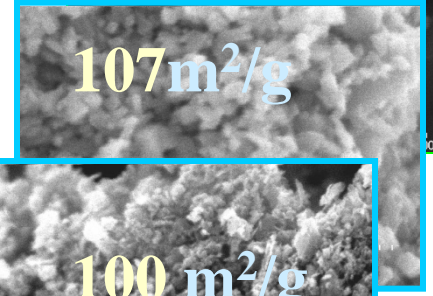
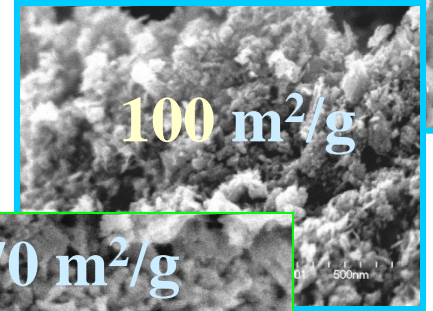
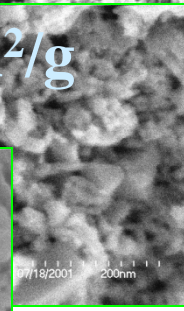
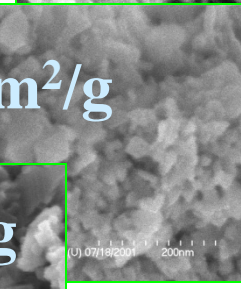
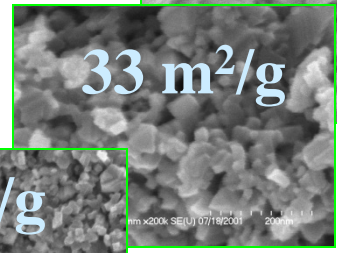
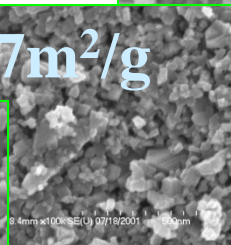
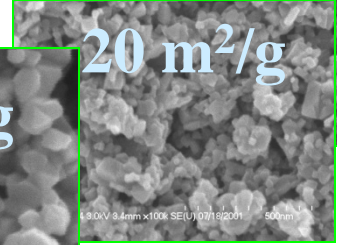
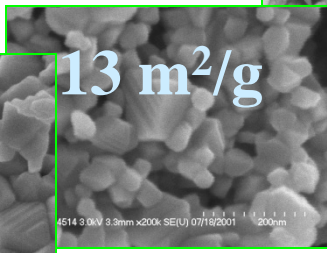
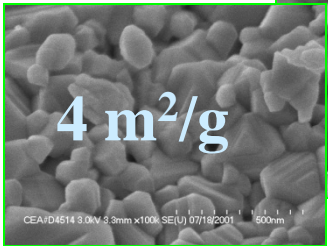
33 m<sup>2</sup>/g

27m<sup>2</sup>/g

20 m<sup>2</sup>/g

13 m<sup>2</sup>/g

4 m<sup>2</sup>/g





Bringing future closer

# HE3DA

High Energy 3D Accumulator

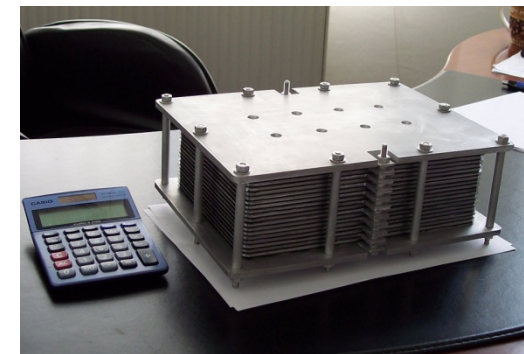
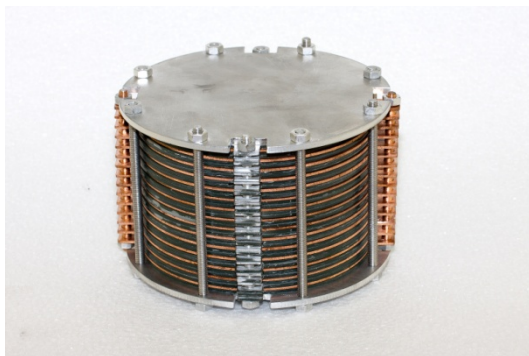


## Three Dimensional Construction of Electrodes - Open Door to High Capacity Lithium Batteries HE3DA®

*Jan Prochazka*

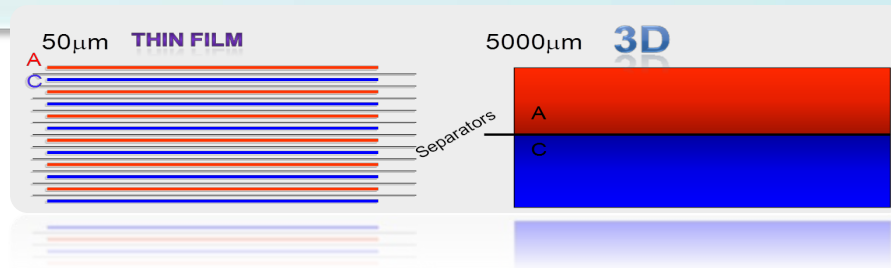
**NANOTECHNOLOGY BASED**

**PATENTS PENDING**



# THE HE3DA<sup>®</sup> DESIGN OF ELECTRODES:

## NEW TECHNOLOGY PLATFORM FOR SAFE HIGH CAPACITY BATTERIES

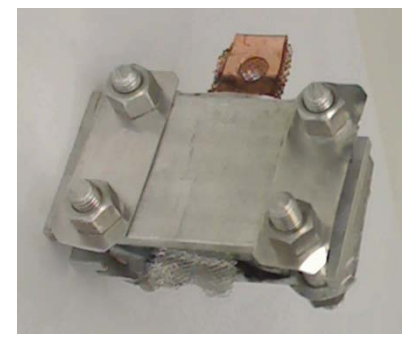


**ACHIEVABLE CAPACITY > 700 Wh/l**

Initially, the project used small prototypes with the volume of 0.15 – 0.5 cm<sup>3</sup>

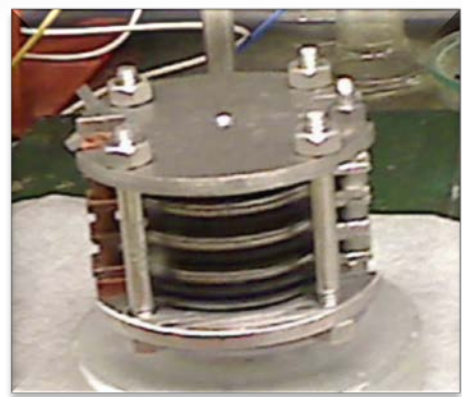


# 3D SCALE UP



significantly **higher volumetric capacities.**

Functionality of the prototypes was experimentally verified in thousands of measurements.



Present development - 10Wh prototypes



**SOLUTION FOT THE NEXT Li ION BATTERY PERFORMANCE LEVEL**