



Литиево Йонните Батерии

Високо Ефективен и Надежден Източник за
Съхранение на Енергия

Проф. Д-р Бранимир Банов





Very large applications





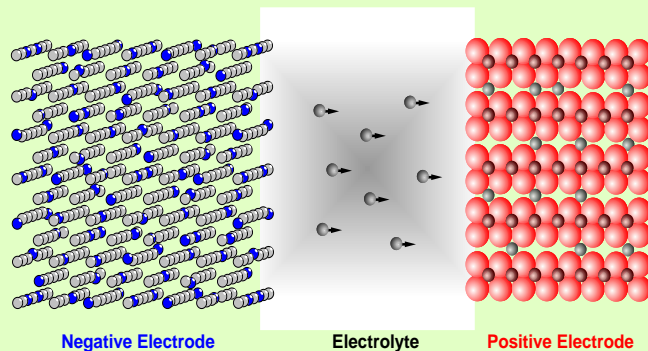
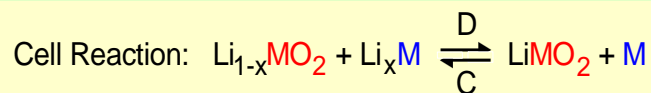
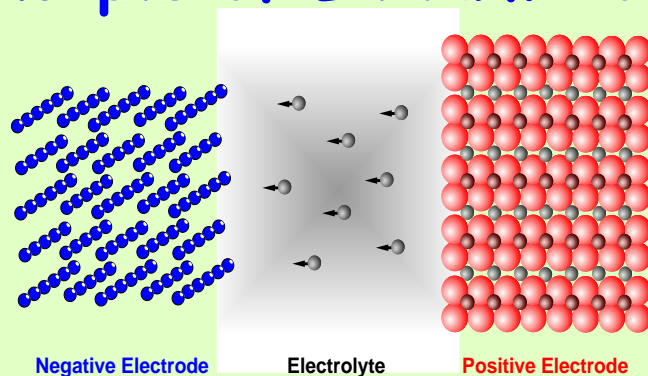
Features of typical lithium battery

- High energy density - gravimetric and volumetric ($>250\text{Wh.kg}^{-1}$)
- High discharge voltage - within 3.0-4.5 Volts
- High charge and discharge rates C/3 - 1C - 10C (30C! drone)
- Wide temperature range of operation $-40^{\circ}\text{C} - +85^{\circ}\text{C}$
- Application:
 - 3C segment of the market
 - HEV & PHEV,
 - high efficient energy storage





Basic concepts of Lithium-Ion Cell





Milestone

Primary lithium batteries – 1970,

Three electrochemical systems:

- liquid cathodes Li/SOCl_2 , Li/SO_2
- solid cathode Li/MnO_2

Secondary (rechargeable) lithium batteries – 1990

“Moli Energy”, Canada, established in 1978, by *Dr. J. Stales*, first rechargeable lithium cell 1987, “AA”, Li/MoS_2

Lithium ion batteries – 2000

- SONY – $\text{LiCoO}_2/\text{C}^*$ introduced by *Prof. A. Kozawa, IBA*





Applications

Stationary

- Neighborhood Energy Storage
- *Renewable Energy Integration*
- UPS and Telecom

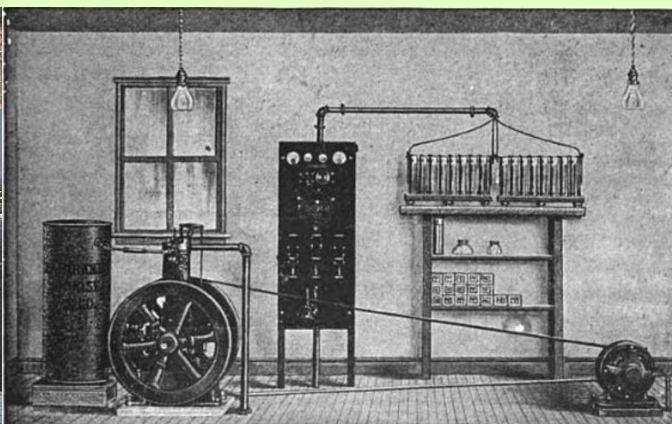
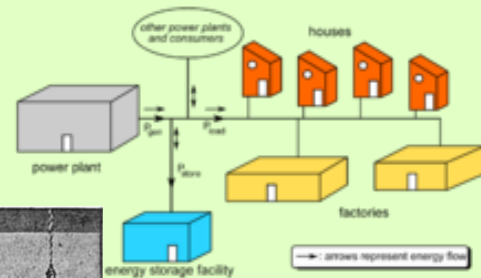
Transportation / Propulsion / Mobile

- *HEV & PHEV* V2G
- Utility & Specialty Platforms
- Auxiliary Power Units (APU)





Load leveling power stations



20# container 250kW/250kWh

40# container 500kW/500kWh



Stationary application

Battery type	Capacity Commercial units	Description
Lead acid flooded	10MW/40MWh	n~70% cost 50-250 Euro/kWh, life span 1000-2000 cycles, at depth of discharge 70%, operating temperature -5°C to 40°C 25Wh/kg, self discharge -less than 5% per month
Lead acid valve regulated	300kW/580kWh	n~70% cost 100-250 Euro/kWh, life span 200-300 cycles, at depth of discharge 80%, operating temperature -5°C to 40°C 25-50Wh/kg, self discharge - less than 5% per month, safe (compared to flooded), negligible maintenance
Nickel Cadmium & Ni/MH	27MW/6.8MWh	n~70% cost 200-600 Euro/kWh, life span 3000 cycles, at depth of discharge 100%, operating temperature -40°C to 50°C 45-80Wh/kg, self discharge - less than 20% per month, high discharge rates, safe, negligible maintenance
Lithium ion	250kW/600kWh	n<90% cost 300-700 Euro/kWh, life span 3000 (8000!) cycles, at depth of discharge 80%, operating temperature -30°C to 60°C 90-180Wh/kg, self discharge - less than 1% per month, high discharge rates, negligible maintenance, internal over charge and discharge protection(!)



Mobile Applications





Example for mobile application

Total Number of Cells per System			
Individual Cell (basic element in a Battery)	Large Cylindrical Cell 18650 (~ 3 Ah)	Large "Pouch" Cell (10 Ah)	Large prismatic Cells 30 Ah to 200 Ah
48V 4 kWh (typical golf cart)	378 Cells Very low reliability	112 Cells acceptable	14 Cells @ 80 Ah Excellent
300V 50 kWh (typical electric vehicle)	5088 Cells Reliability = 0!	1536 Cells Extremely low reliability	96 Cells @ 160 Ah Excellent



R&D Team with Long Experience & Work in Special Conditions

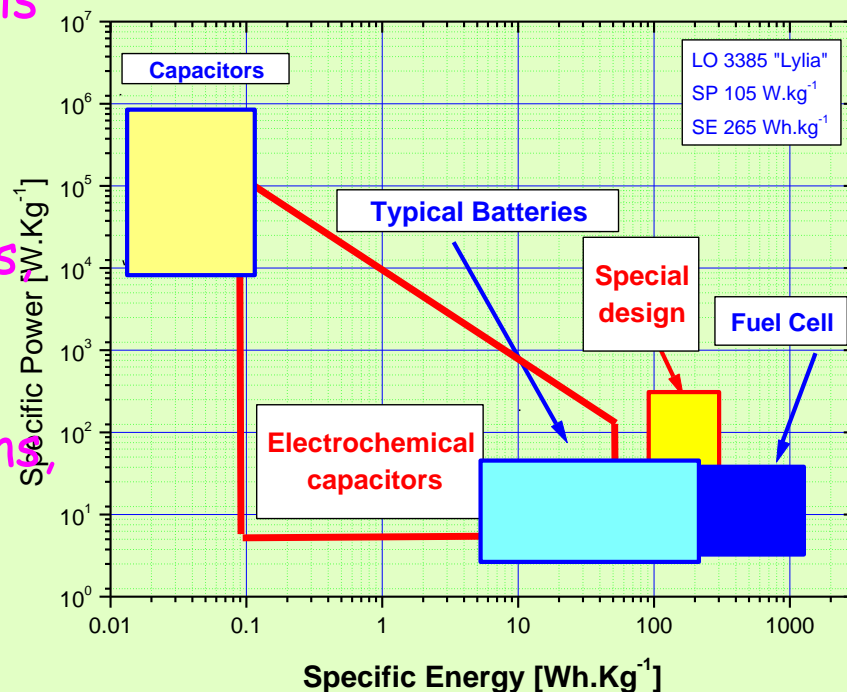


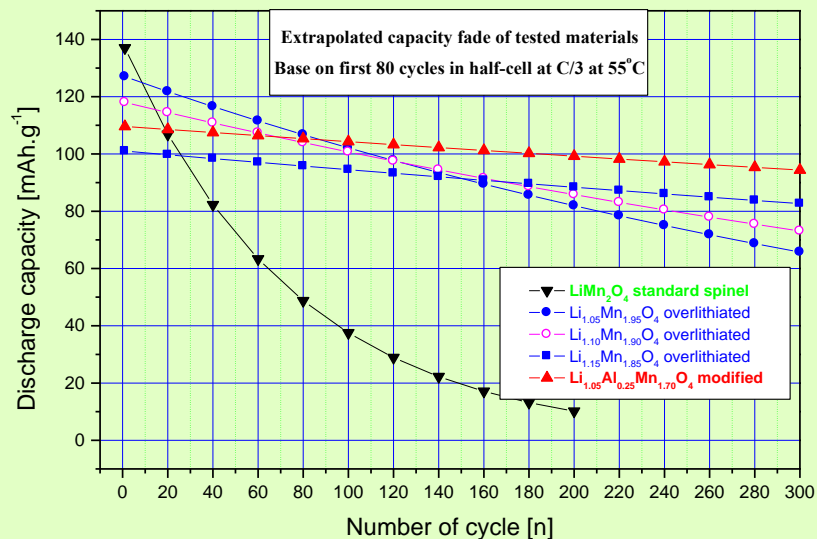


Current and future trends in R&D

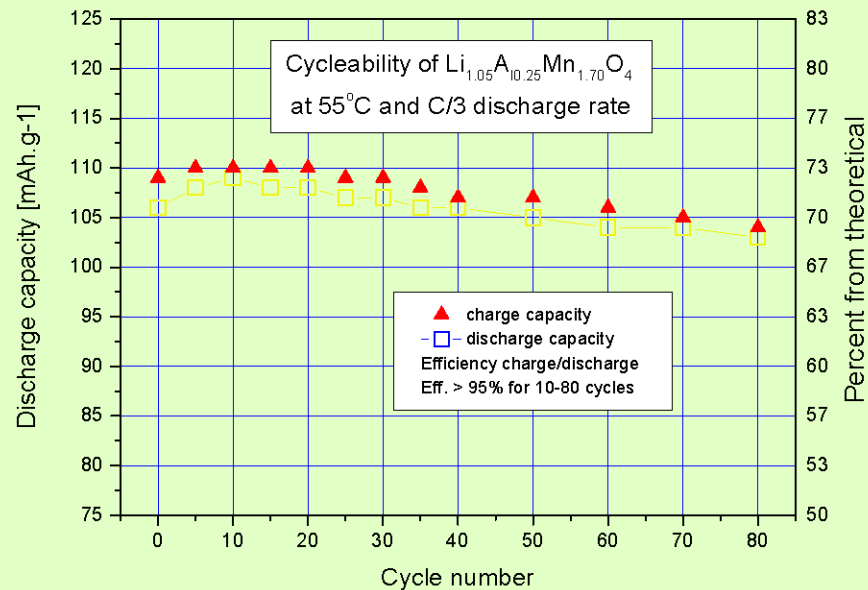
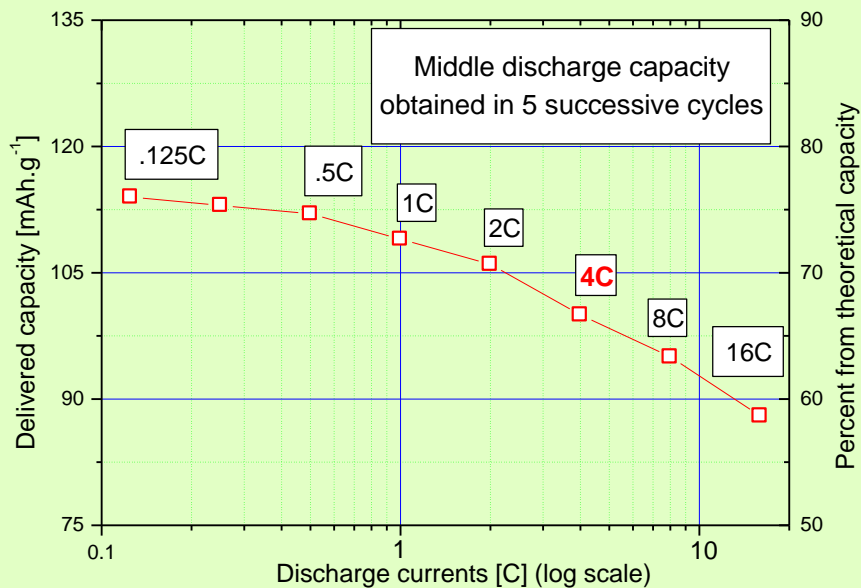
High Efficient Active Electrode Materials

- New advanced nanosized materials - cathodes and anodes
- New synthesis routes, sol-gel, hydrothermal, SSR
- Electrode engineering properties: pore distribution, multilayer, etc.
- Composite materials
- Enhanced electrolyte composition, additives
- High energy density materials
- 600Wh.g^{-1}



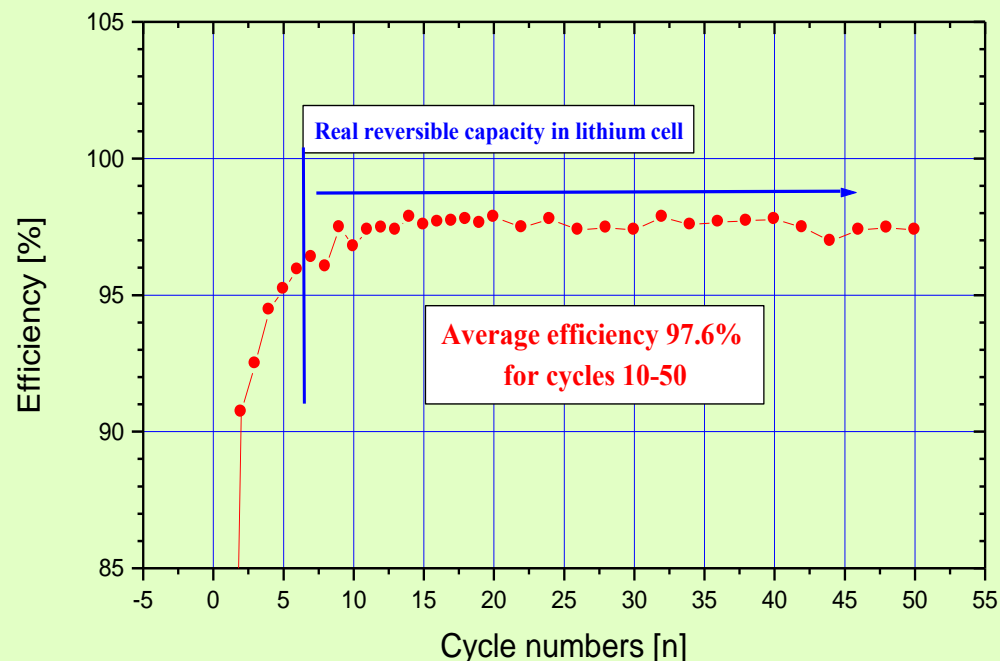
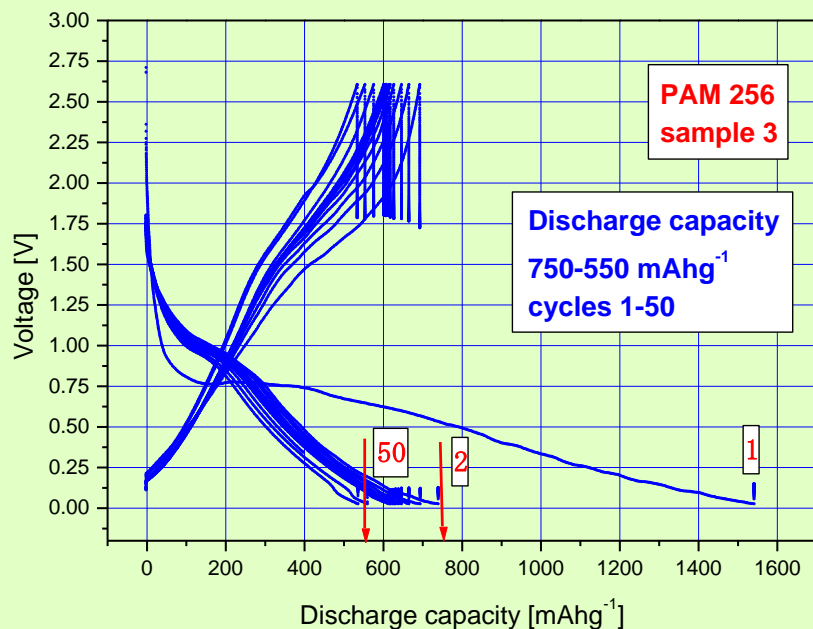


Characteristics of modified manganese spinel





New prospective anode material based on metal oxide incorporated in carbon matrix

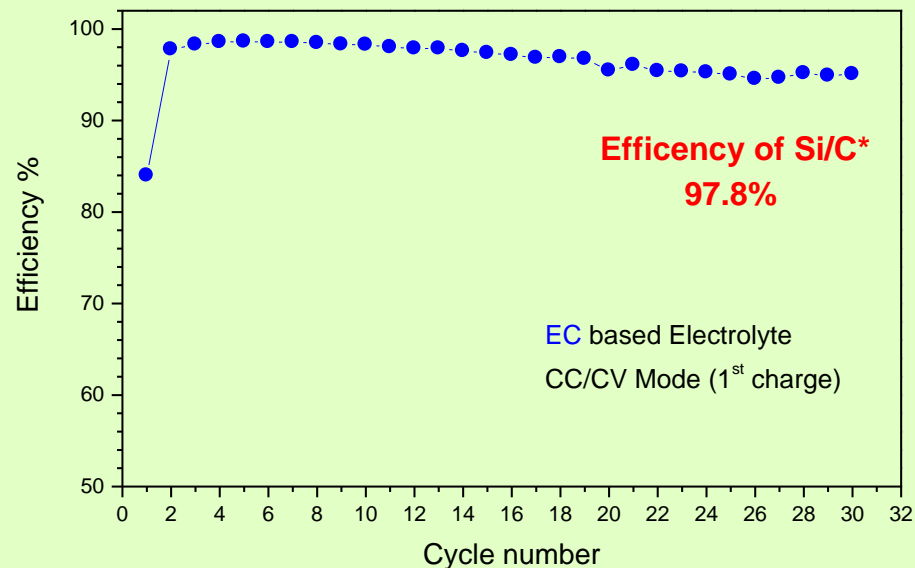
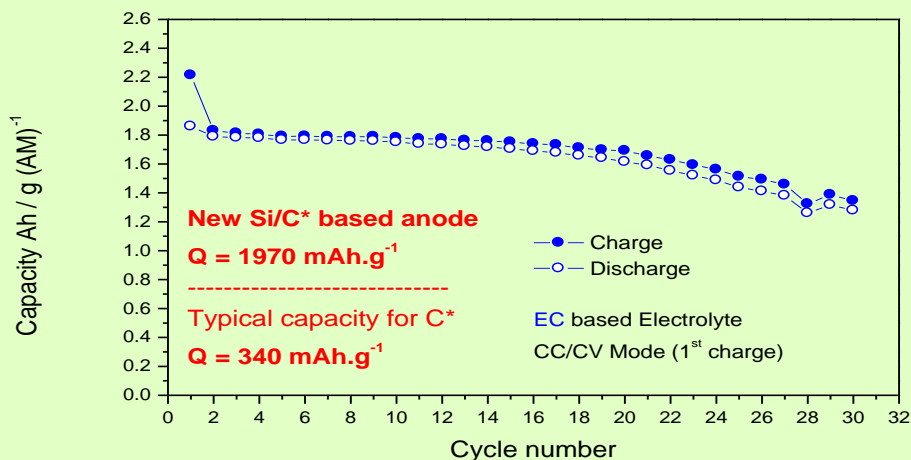
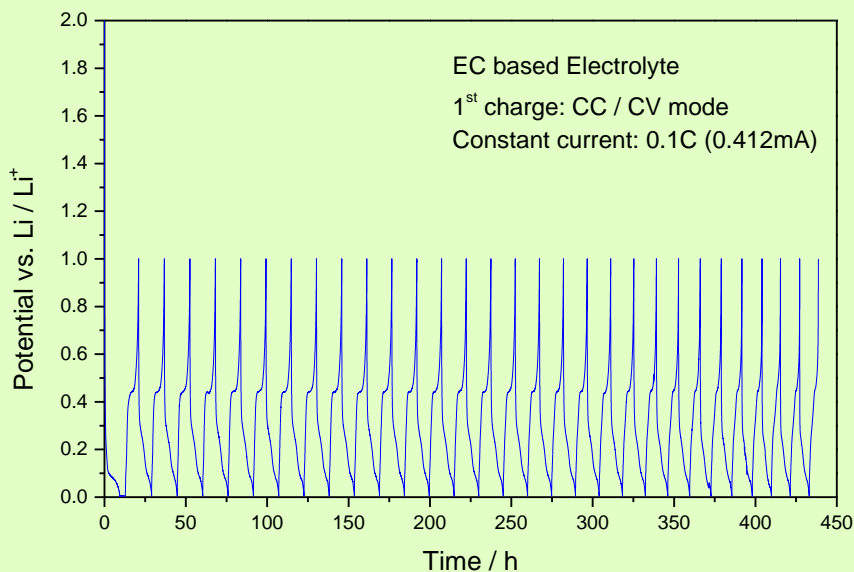


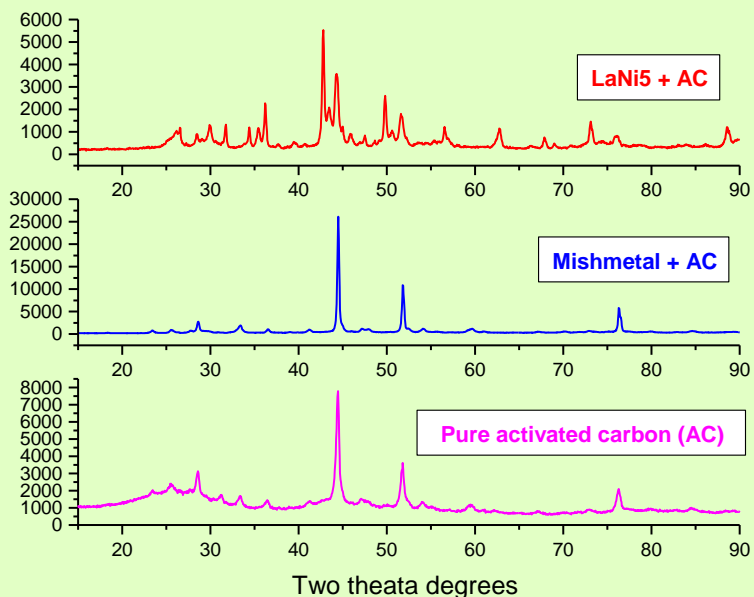


New Silicon/Carbon based anode material with capacity

1970 mAh.g⁻¹

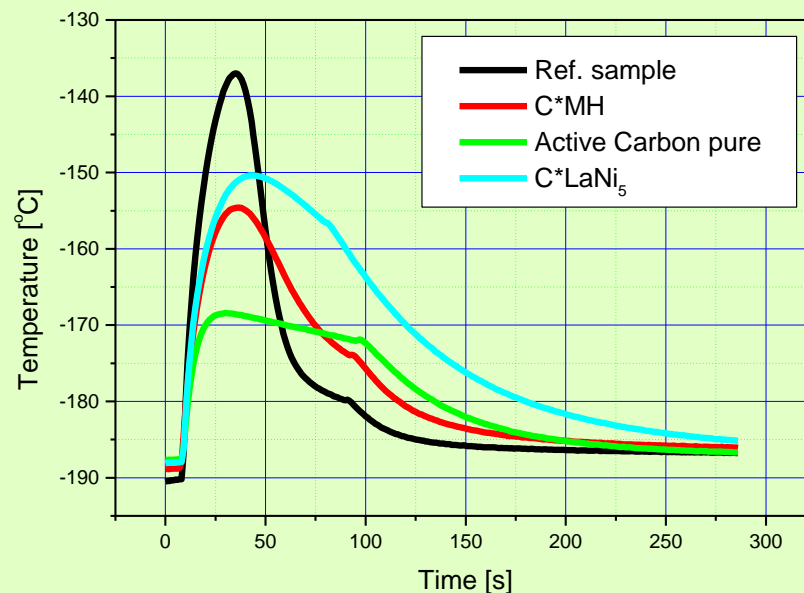
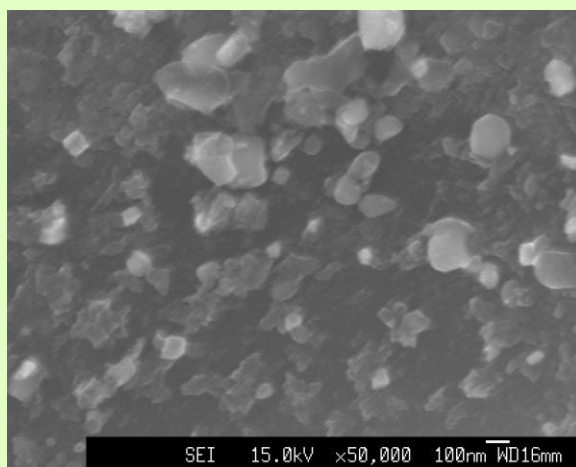
Pure Carbon 340 mAh.g⁻¹





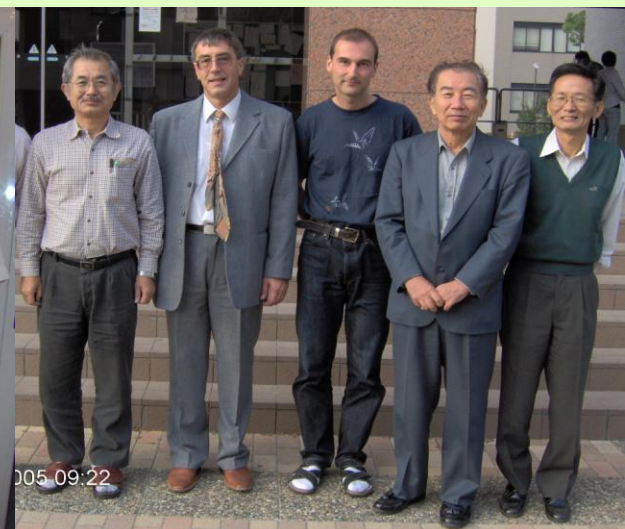
Hydrogen storage materials based on carbon matrix composite metal/metal oxides

SEM of
MH(LN)/AC
Me/AC
34:66 (28:72)





International Cooperation





Благодаря за Вниманието

