Advantages of Laser Electrodispersion for the Synthesis of CO Oxidation Catalysts with Low Loading of Precious Metals

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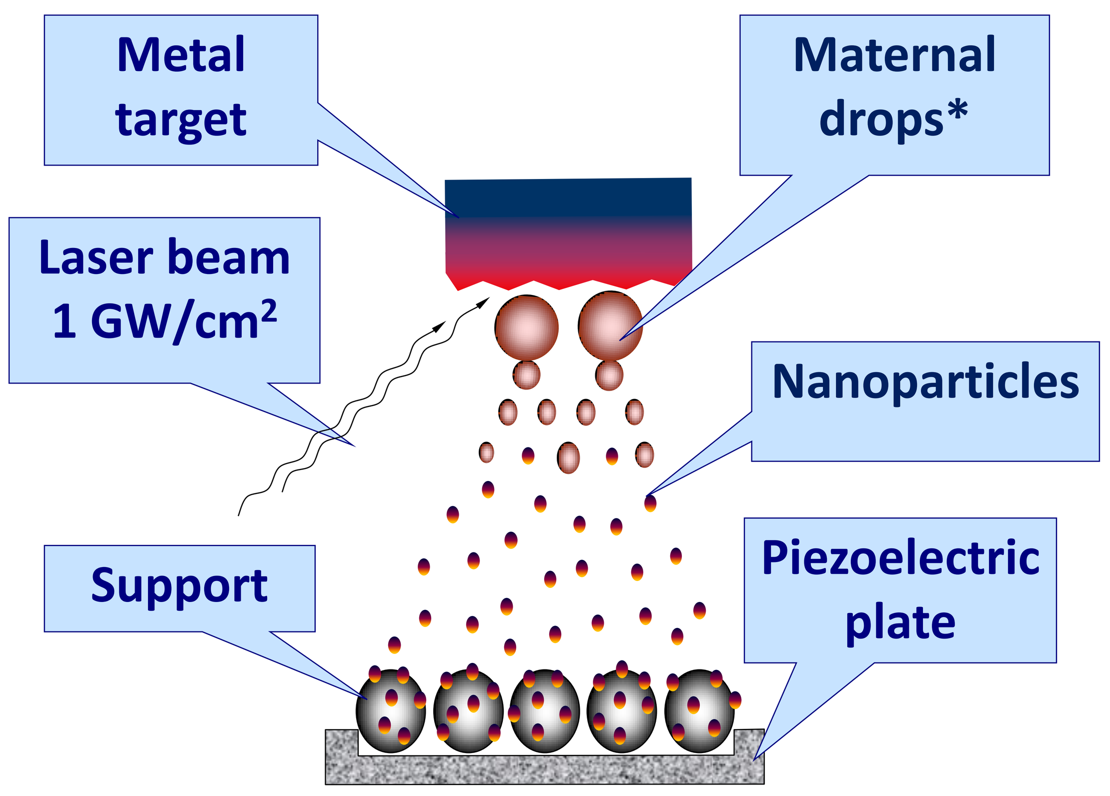
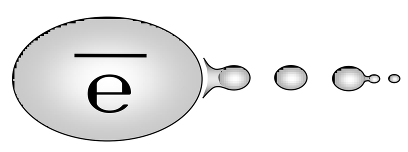
LED Technique



* *Cascade Drop Fission*



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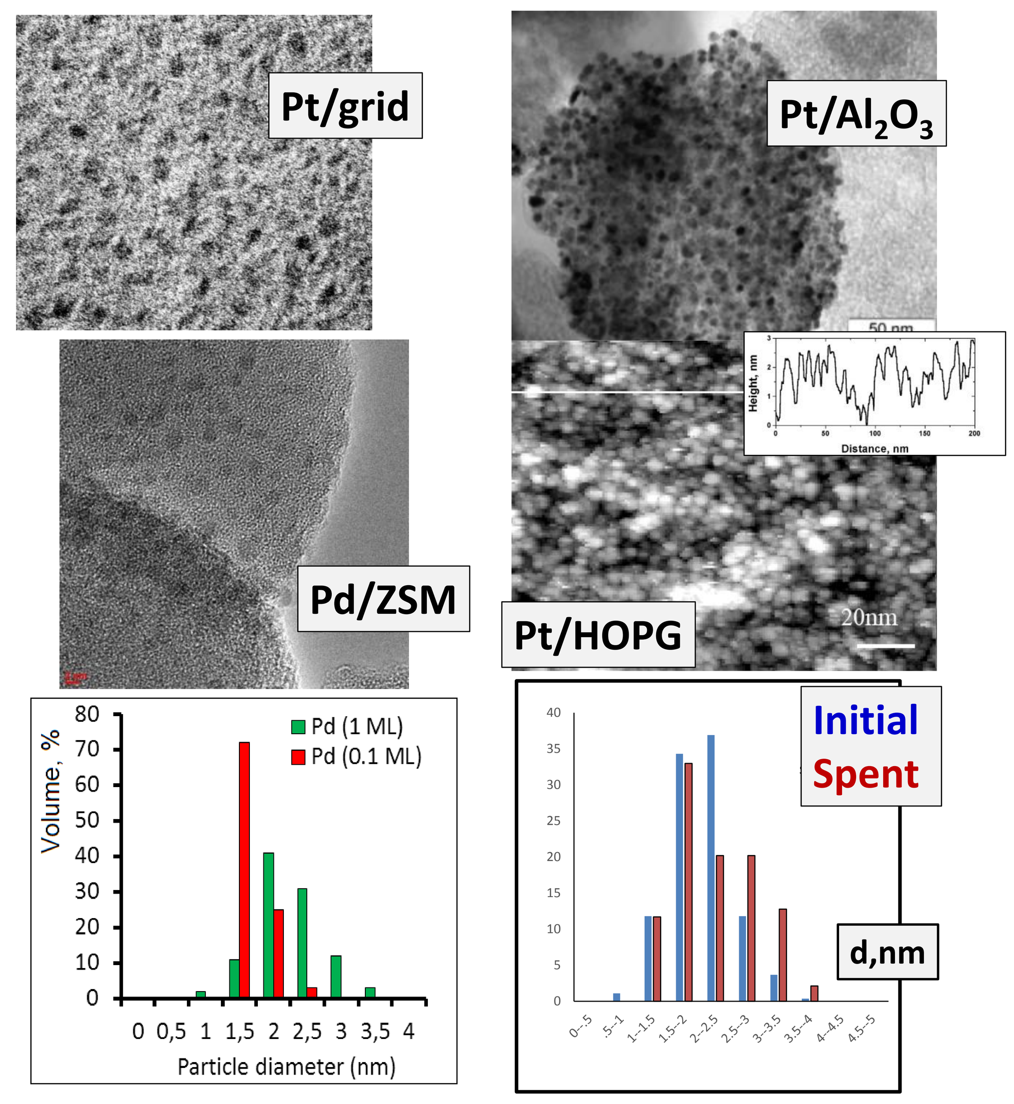
Advantages

- Deposition of one-size single particles;
- "Crustlike" distribution;
- High resistance to aggregation;
- Particle size independence from the support and metal loading;
- Linear dependence of metal loading on the deposition time

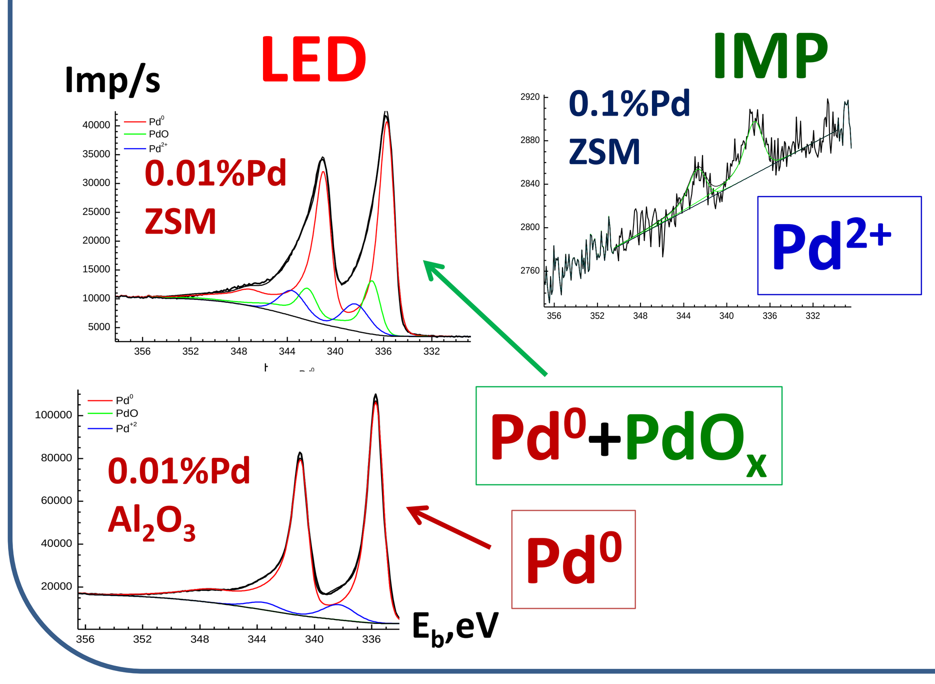
Objective – Application of laser electrodispersion (LED) method to design low loaded Pd and Pt catalysts for the total (TOX) and preferential (PROX) CO oxidation

Pd and Pt catalysts



TEM and STM images

XPS studies



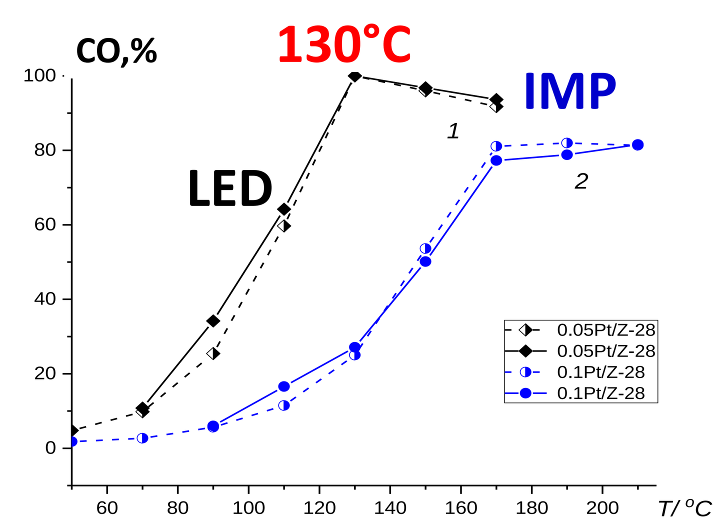
Support	E$_b$,eV	71.5	72.5	74.3	Pt/Si+Al or Pt/Al
ZSM-5	Pt4f$_{7/2}$	Fraction, at,%			
Si/Al	Pt,wt.%	Pt^0	PtO	PtO$_x$Al	
15	0.01	36	21	43	0.04
28	0.01	35	49	16	0.11
H$_2$, 150-450°C		79	18	3	0.10
28	0.05	61	24	15	0.22
Al$_2$O$_3$	0.02	91	7	2	1.8

PROX - H$_2$-rich mixture

1 CO, 1 O$_2$, 49 H$_2$, 49 He (vol.%)

$CO + 1/2O_2 \longrightarrow CO_2$

$H_2 + 1/2O_2 \not\longrightarrow H_2O$



1- 0.05Pt (LED)
2 - 0.1Pt (IMP)
ZSM-5

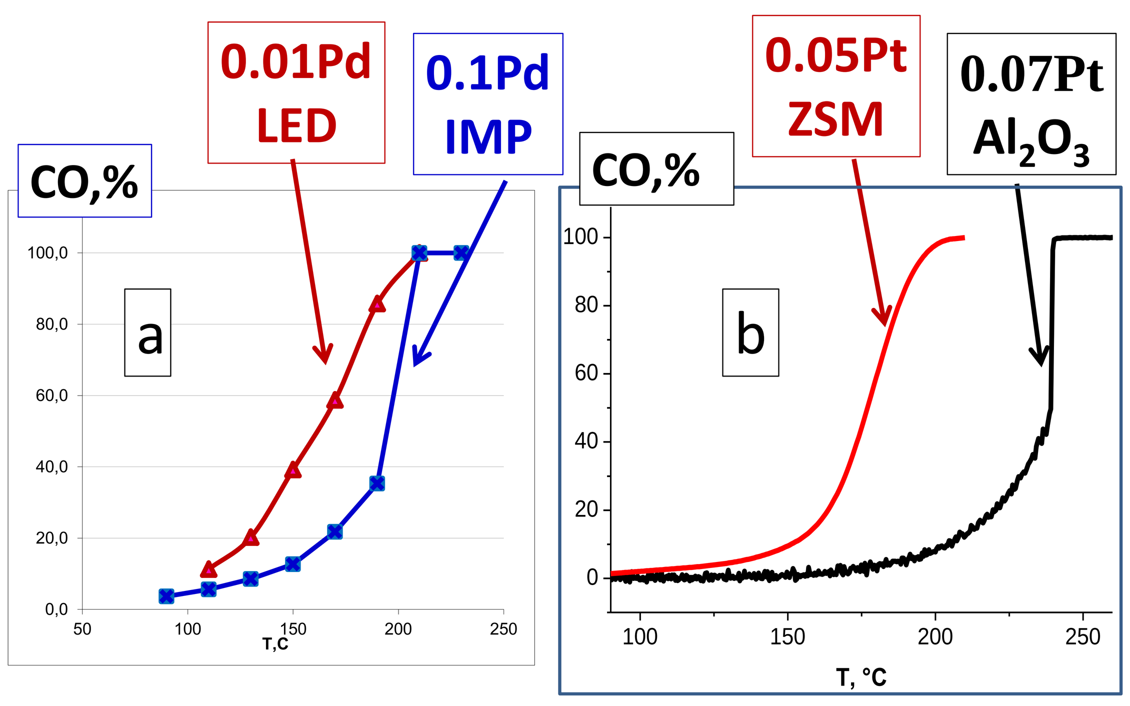
CO conversion – Temperature dependences

High-performance catalysts for TOX and PROX CO oxidation

TOX - model mixture

1 CO, 1 O$_2$, 98 He (vol.%)

metal	support	M^0, %	T$_{50}$,°C
Pd	Al2O3	95	180
0.01%	ZSM-5	62	165
Pt	Al2O3	91	294
0.01%	ZSM-5	35	233



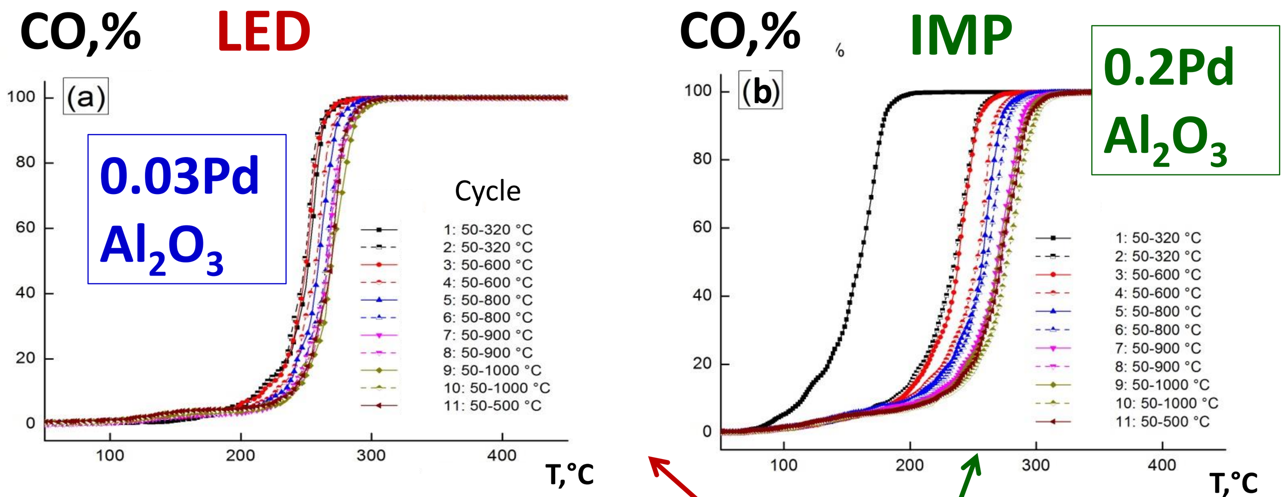
CO conversion -Temperature dependences on catalysts: Pd/ZSM (a) and Pt (LED-b)

TOX - reaction mixture

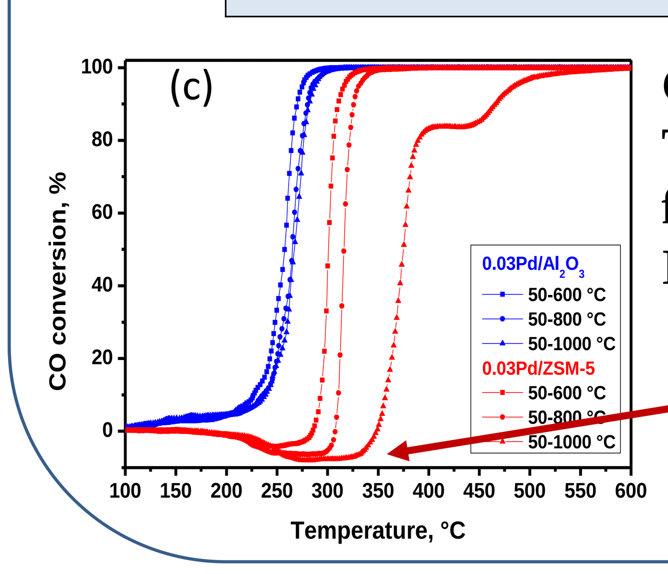
(Model for three way catalysts)

CO, CH$_4$, C$_3$H$_4$, C$_6$H$_5$CH$_3$, NO, O$_2$ and N$_2$

Promt thermal aging at temperatures up to 1000 °C



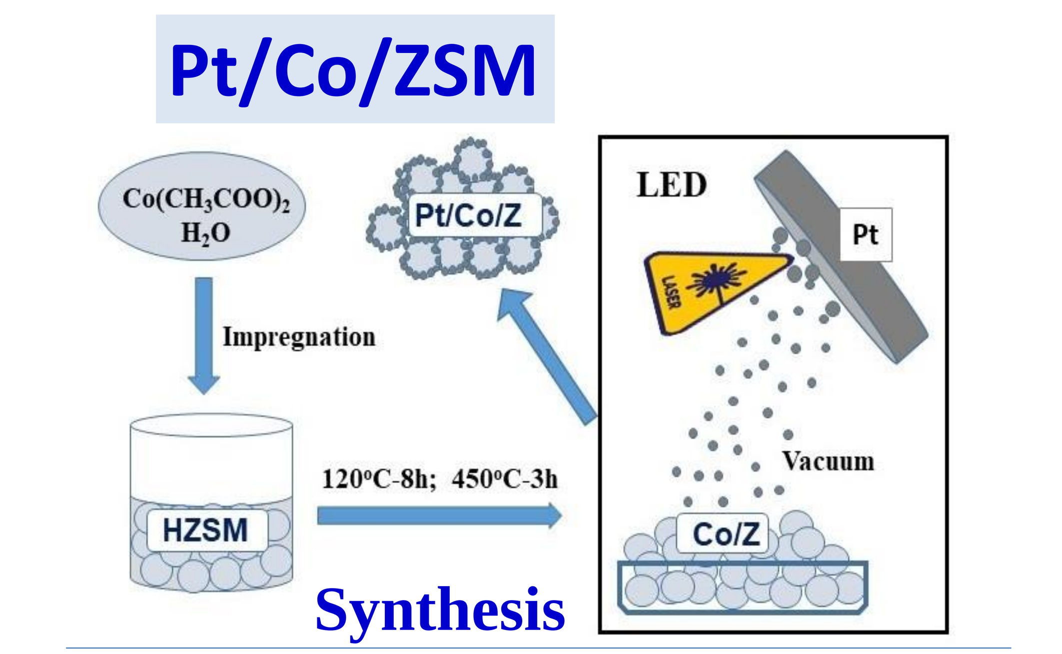
Δ T$_{50}$$^{1000-320}$,°C	17	118

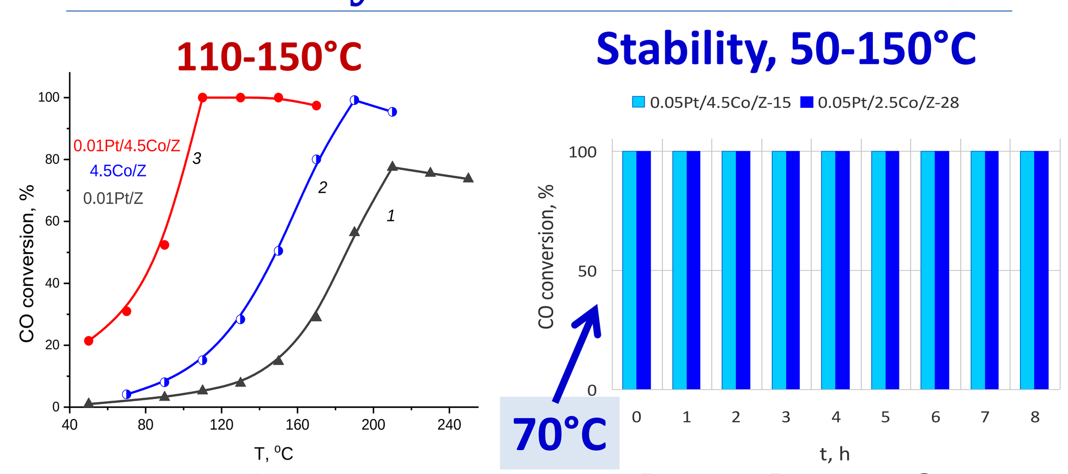


CO conversion – Temperature dependences for Pd/Al$_2$O$_3$ (a,c-LED and b-IMP) and Pd/ZSM (c-LED)

0.03Pd/ZSM as hydrocarbon traps

Pt/Co/ZSM





CO conversion-Temperature dependences for 0.01Pt (1), 2.5Co (2) and 0.01Pt/2.5Co (3) on ZSM

Conclusions

LED prepared Pd catalysts are the best for TOX; Catalysts on ZSM are more active, but Pd/Al$_2$O$_3$ are the most stable.
LED prepared Pt/ZSM are more efficient for PROX. Their catalytic properties are improved when Pt nanoparticles are deposited on Co-ZSM.

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