

INTiBS PAN



WROCŁAW

# Implementation of selected research findings from ILT&SR PAS as a step toward circular economy in Lower Silesia

Adam Watras, Ph.D.

*Director's Proxy for Popularization of Science  
Institute of Low Temperature and Structure Research  
Polish Academy of Sciences*

- ILT&SR PAS – basic information and research field
- Rare earths elements market
- Recovery of lanthanides from Lower Silesia sources
- Use of lanthanides in ILT&SR PAS research
- The path of commercialization for technologies developed in ILT&SR PAS
- Acknowledgements

## Institute of Low Temperature and Structure Research of Polish Academy of Sciences (ILT&SR PAS)

- Division III: Mathematics, Physics, Chemistry and Earth Sciences;
- Research interests – wide research of physicochemical structure of solid state and connection to physical, chemical and spectroscopic properties, especially in low temperatures. Institute's specialty are investigations of magnetic  $5f$ - and  $4f$ -electron systems, superconductors, physics of phase transitions and molecular spectroscopy
- Institute's objectives: conducting scientific research (mostly basic, pre-application studies); scientific training of researchers and specialists with qualifications connected with Institute's interests and used research methods; cooperation with universities and colleges in teaching duties; smoothing the way of applying of the obtained results; supporting of the governmental units in metrological duties; and popularization of knowledge connected with Institute's interests.

# Rare earths elements market

Period	Group 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	1 H 1.008																	2 He 4.003
2	3 Li 6.941	4 Be 9.012											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16	9 F 19	10 Ne 20.18
3	11 Na 22.99	12 Mg 24.31											13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.07	17 Cl 35.45	18 Ar 39.95
4	19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.88	23 V 50.94	24 Cr 52	25 Mn 54.94	26 Fe 55.85	27 Co 58.47	28 Ni 58.69	29 Cu 63.55	30 Zn 65.39	31 Ga 69.72	32 Ge 72.59	33 As 74.92	34 Se 78.96	35 Br 79.9	36 Kr 83.8
5	37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc (98)	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3
6	55 Cs 132.9	56 Ba 137.3	57 La 138.9	72 Hf 178.5	73 Ta 180.9	74 W 183.9	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197	80 Hg 200.5	81 Tl 204.4	82 Pb 207.2	83 Bi 209	84 Po (210)	85 At (210)	86 Rn (222)
7	87 Fr (223)	88 Ra (226)	89 Ac (227)	104 Rf (257)	105 Db (260)	106 Sg (263)	107 Bh (262)	108 Hs (265)	109 Mt (266)	110 Ds (271)	111 Rg (272)	112 Uub (285)	113 Uut (284)	114 Uuq (289)	115 Uup (288)	116 Uuh (292)	117 Uus 0	118 Uuo 0
			6	58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm (147)	62 Sm 150.4	63 Eu 152	64 Gd 157.3	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173	71 Lu 175	
			7	90 Th 232	91 Pa (231)	92 U (238)	93 Np (237)	94 Pu (242)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (249)	99 Es (254)	100 Fm (253)	101 Md (256)	102 No (254)	103 Lr (257)	

## Selected applications of rare earths elements (REE)

- automotive catalytic converters
- fluid cracking catalysts in petroleum refining
- phosphors in color television and flat panel
- displays (cell phones, portable DVDs and laptops)
- permanent magnets and rechargeable batteries for hybrid and electric vehicles, generators for wind turbines and medical devices
- defense applications - jet fighter engines, missile guidance systems, antimissile defense
- space-based satellites and communication systems.

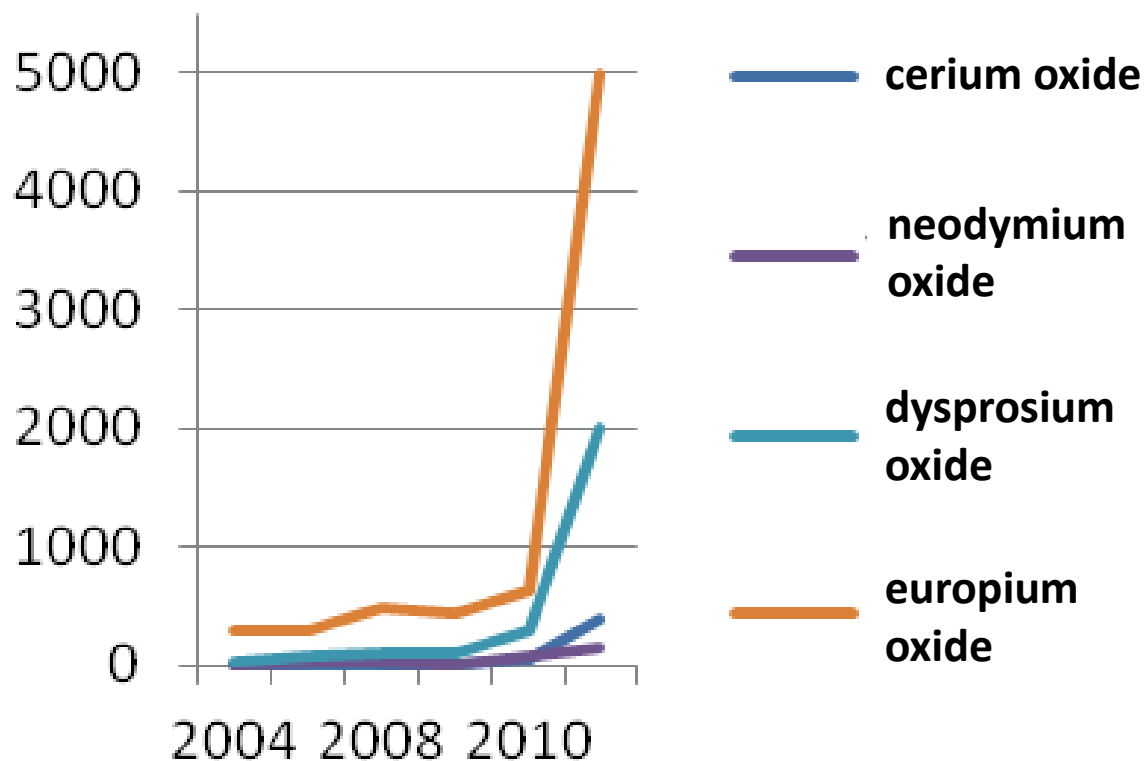
## Major REE producers in the world

<b>country</b>	<b>production t/y</b>	<b>share of global market %</b>
China	30 000	> 93
USA	3 500	2.5
India	3 000	2.1
Russia	2 000	1.4
Brazil	550	-
Malaysia	30	-

# Rare earths elements market



\$ USD/kg



Recovery of REE from anthropogenic sources such as electric and electronic waste, production sludges, sediments, mineral processing waste etc.

## **PHOSPHOGYPSUM**

a byproduct of the processing of phosphate ore, mainly in the production of fertilizers.



# Recovery of lanthanides from Lower Silesia sources

## Chemical Works „Wizów”

During its activity the chemical plant collected in a waste dump about several million ton of gypsum containing 8.000 tons REEs, including 200 t of yttrium and 30 t europium.



# Recovery of lanthanides from Lower Silesia sources



- Based on the experiments carried out a method of lanthanides recovery from waste apatite phosphogypsum was proposed enabling to utilize this waste and convert it into safe product intended for construction purposes.
- The study of lanthanides extraction from the waste phosphogypsum using sulfuric acid solution proved that the possible recovery level is about 50÷60 % in relation to the initial lanthanide amount.
- Share of particular  $\text{Ln}_2\text{O}_3$  in the final product is as follows [%]:

$\text{CeO}_2$	48÷51
$\text{La}_2\text{O}_3$	24 ÷ 26
$\text{Nd}_2\text{O}_3$	14.5 ÷ 15.2
$\text{Pr}_6\text{O}_{11}$	5.5÷6
$\text{Eu}_2\text{O}_3$	0.4÷0.5
$\text{Sm}_2\text{O}_3$	2.0÷2.2
$\text{Y}_2\text{O}_3$	1.5÷2.0
$\text{Gd}_2\text{O}_3$	0.8÷1.2

## Division of Magnetic Research

- spintronic
- renewable energy sources
- magnetic semiconductors
- quantum computers

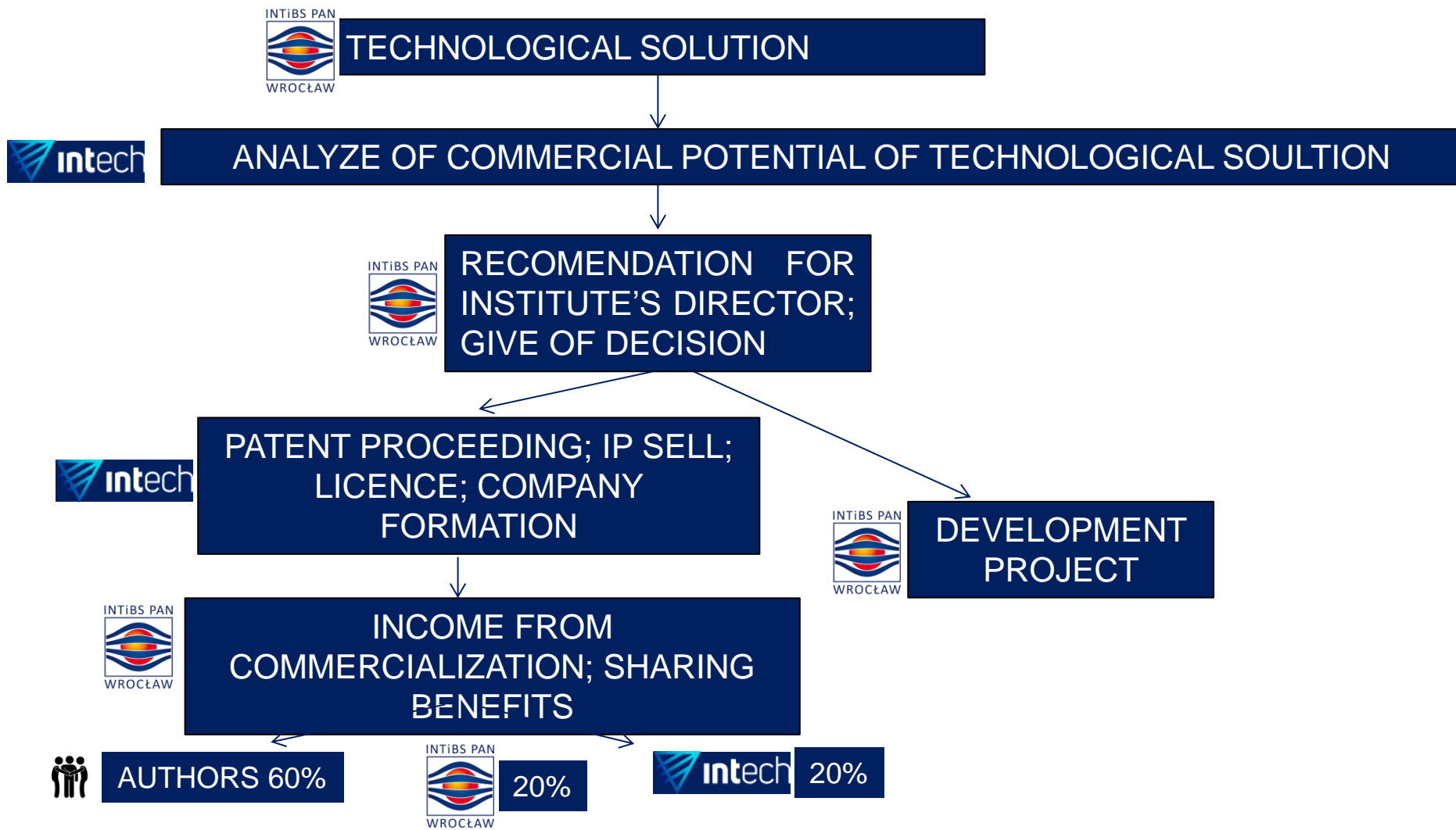
## Division of Optical Spectroscopy

- phosphors for white LEDs
- contactless nanothermometry
- bio-imaging
- quantum dots

# The path of commercialization for technologies developed in ILT&SR PAS



## Commercialization path in ILT&SR PAS



# The path of commercialization for technologies developed in ILT&SR PAS



**iPANTERM**

- iPANTERM was founded as a result of a long-term R&D work of scientists from the Institute of Low Temperature and Structure Research of Polish Academy of Sciences in Wrocław
- The company aims at commercializing foam silicates (pianosilica) - fire-proof, sol-gel, thermal insulating materials
- They can be to the great extent made of waste that is deposited in industrial dumps or continuously created in mining and industrial processes

# The path of commercialization for technologies developed in ILT&SR PAS



## Commercialization of silicate-foam technology



PATENTS + KNOW-HOW



TAKING OVER SHARES BY THE CREATORS FOR CASH



DARR S.A.

CAPITAL INVESTOR

*obtaining the consents provided by law*

*apportionment*



iPANTERM



# Acknowledgements



- Prof. Kazimierz GRABAS, Wrocław University of Technology
- Tomasz FERENZ, CTT-INTech, Wrocław
- D.Sc Dariusz HRENIAK, iPANTERM, ILT&SR PAS, Wrocław

INTiBS PAN



WROCŁAW

**Thank you for your  
attention!**