

Embedded Temperature Sensors for Thermal Barrier Coatings

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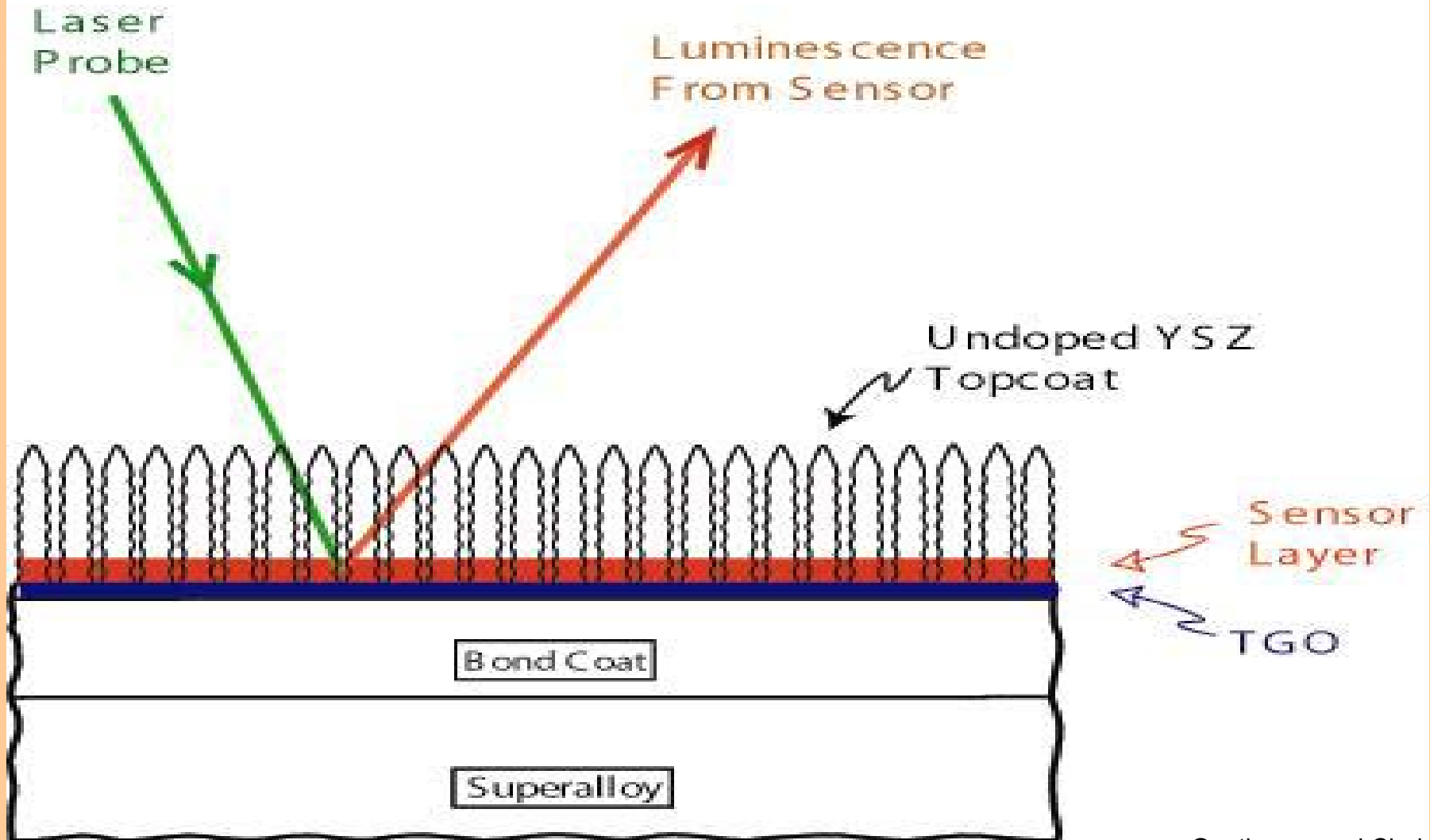


Motivation

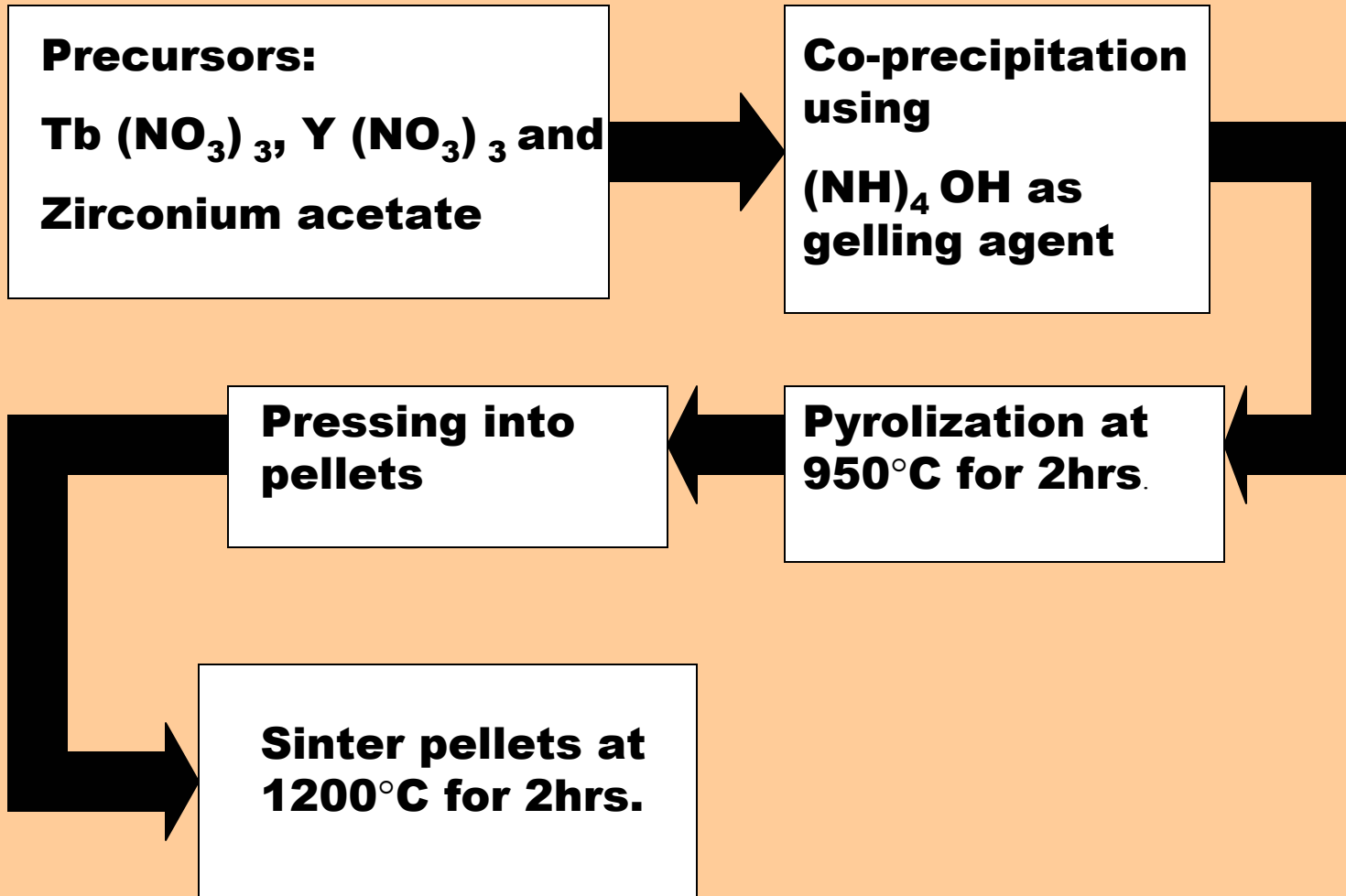
- **Improving the efficiency of gas turbines**
- **Development of non-contact temperature sensors for Thermal Barrier Coatings (TBCs)**
- **Determine if terbium (Tb) is a suitable dopant for embedded sensors**

What are TBCs and how an embedded temperature sensor works:

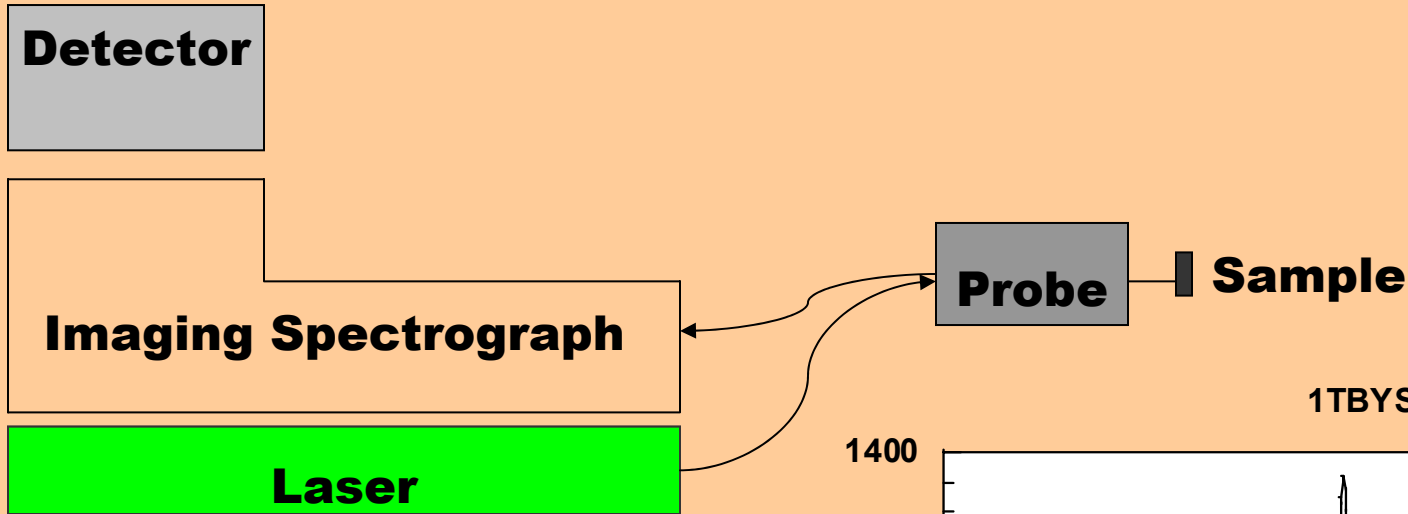
- TBCs are ceramics composed of yttria-stabilized zirconia (YSZ)



Sample Processing



Raman Spectroscopy

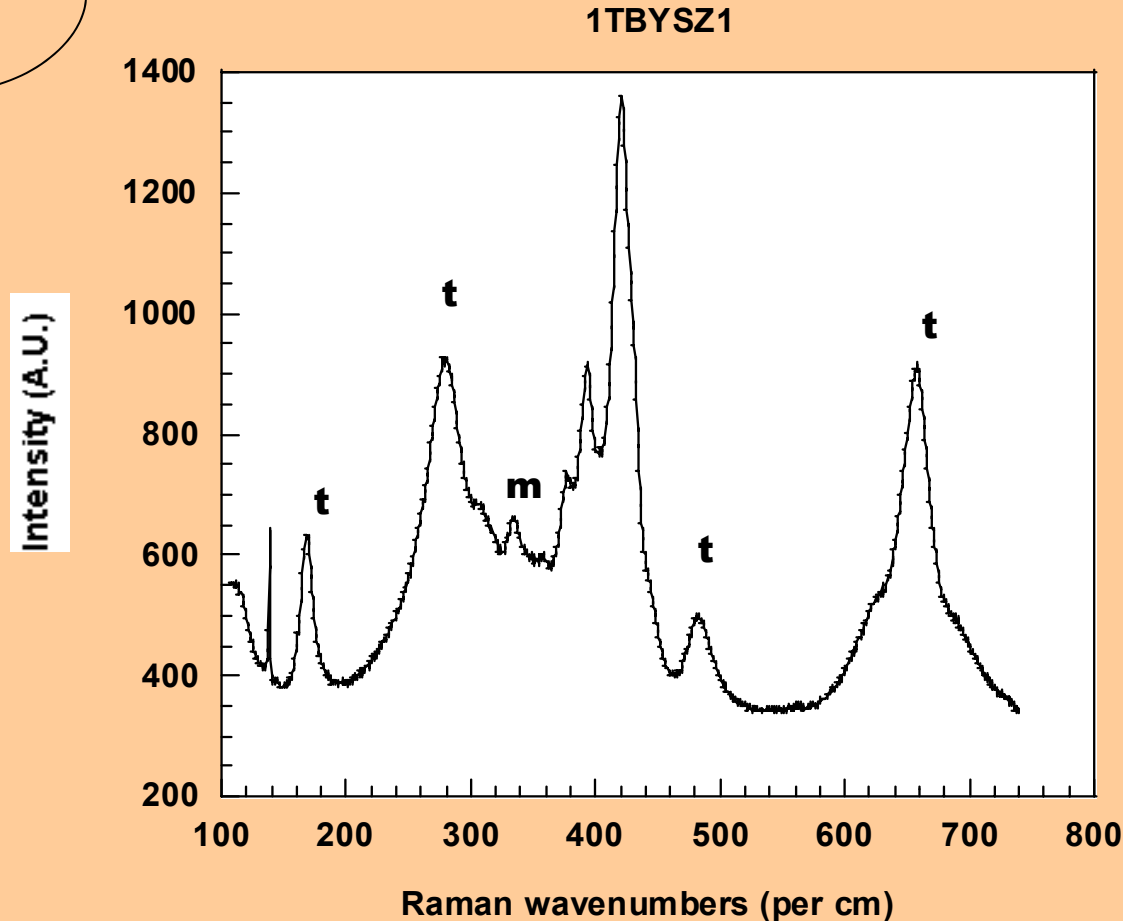


USES:

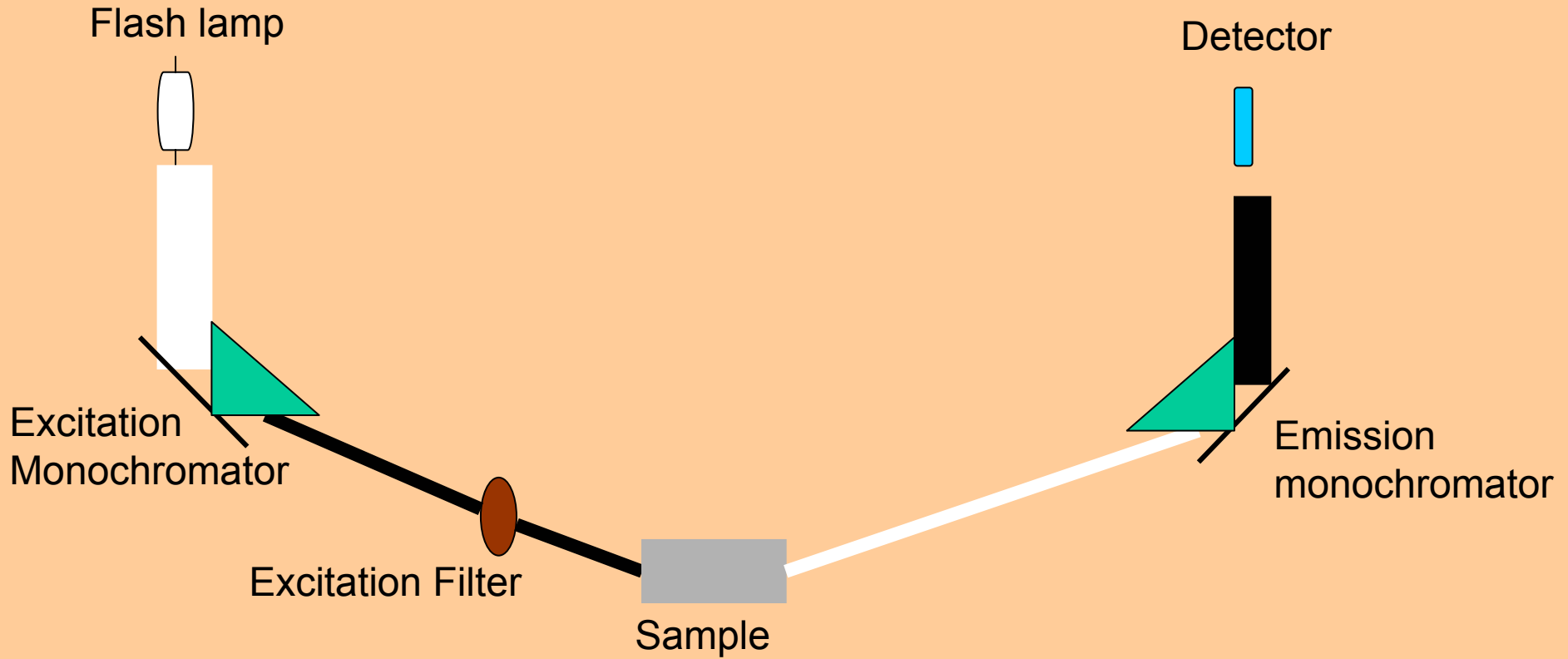
Determines crystal structure for doped YSZ.

Checks stability of crystal structure.

Scans for possible luminescence.



Luminescence Spectroscopy



USES:

- Records spectral emissions
- Shows intensity of luminescence
- Determines excitation wavelength that produces maximum luminescence

How Luminescence works:

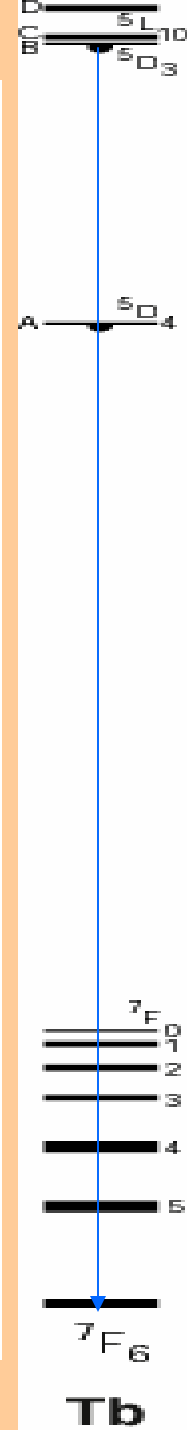
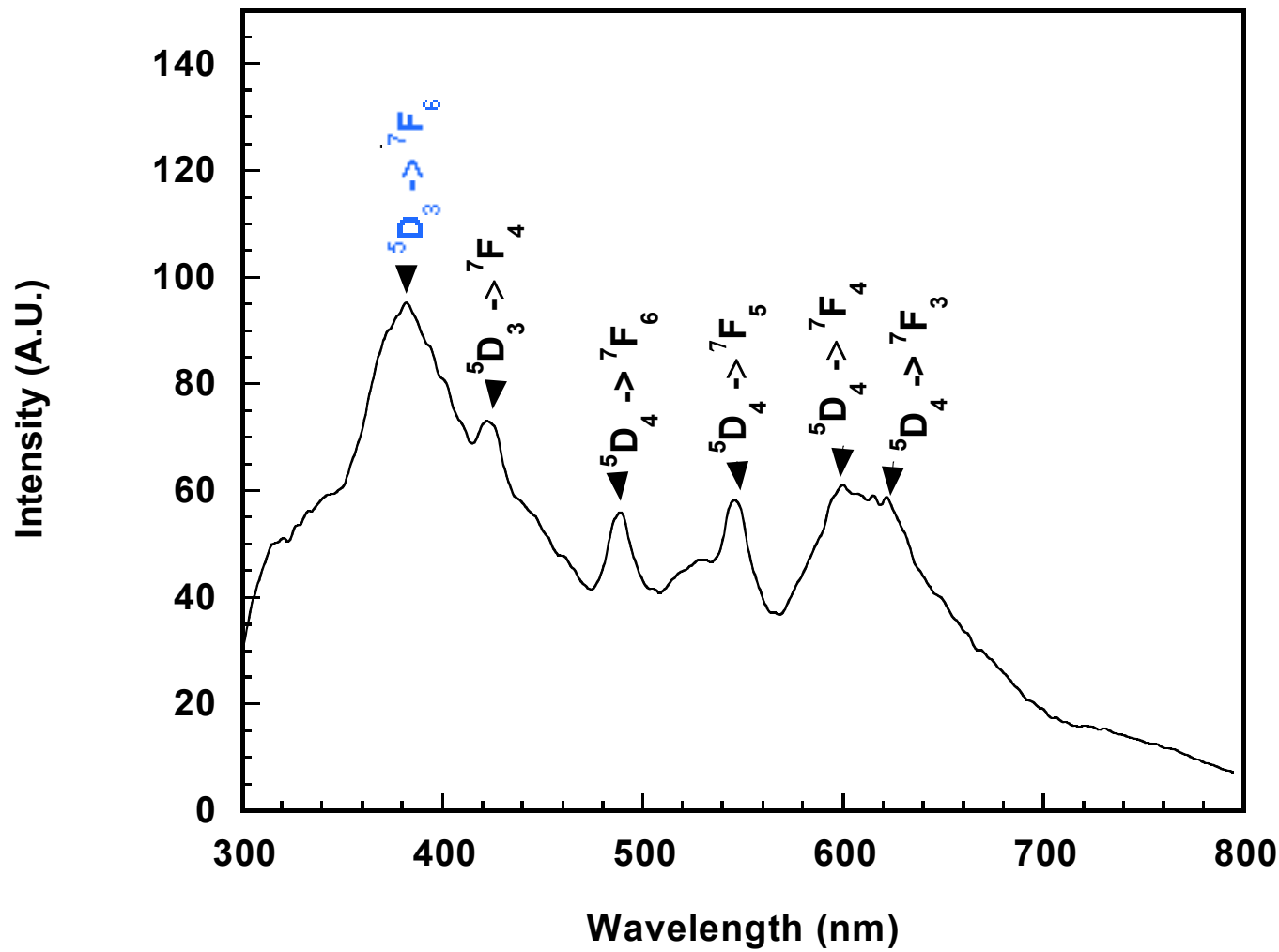
- When yttria-stabilized zirconia (YSZ) is doped with terbium (Tb), it acts as a phosphor
- Phosphors absorb radiation of higher energy and emit radiation at lower energy
- Transition from high to low energy levels causes radiation emission in the visible light, or luminescence



Energy Level Calculations

	7F6	7F5	7F4	7F3	7F2	7F1	7F0	5D4	5D3
7F6	0								
7F5	4848	0							
7F4	3037	8129	0						
7F3	2329	4483	9995	0					
7F2	2022	3468	6047	15310	0				
7F1	1850	2992	4735	8998	21824	0			
7F0	1772	2794	4257	7417	14385	42199	0		
5D4	490	545	584	620	646	666	677	0	
5D3	381	414	436	456	470	481	486	1726	0

Emission Spectra 0.5%Tb:YSZ 248nm excitation



Summary

- **Co-precipitation yields tetragonal crystal structure for Tb-Y codoped partially stabilized zirconia**
- **Tb doped YSZ luminescence can be excited using standard laser wavelengths as shown by luminescence spectroscopy**

Future Plans

- **Further analysis of emission intensities versus Tb concentrations to determine the best concentration for making embedded sensors**

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