Experiment 5:

Absorption, Reflection and Index of Refraction

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Abstract

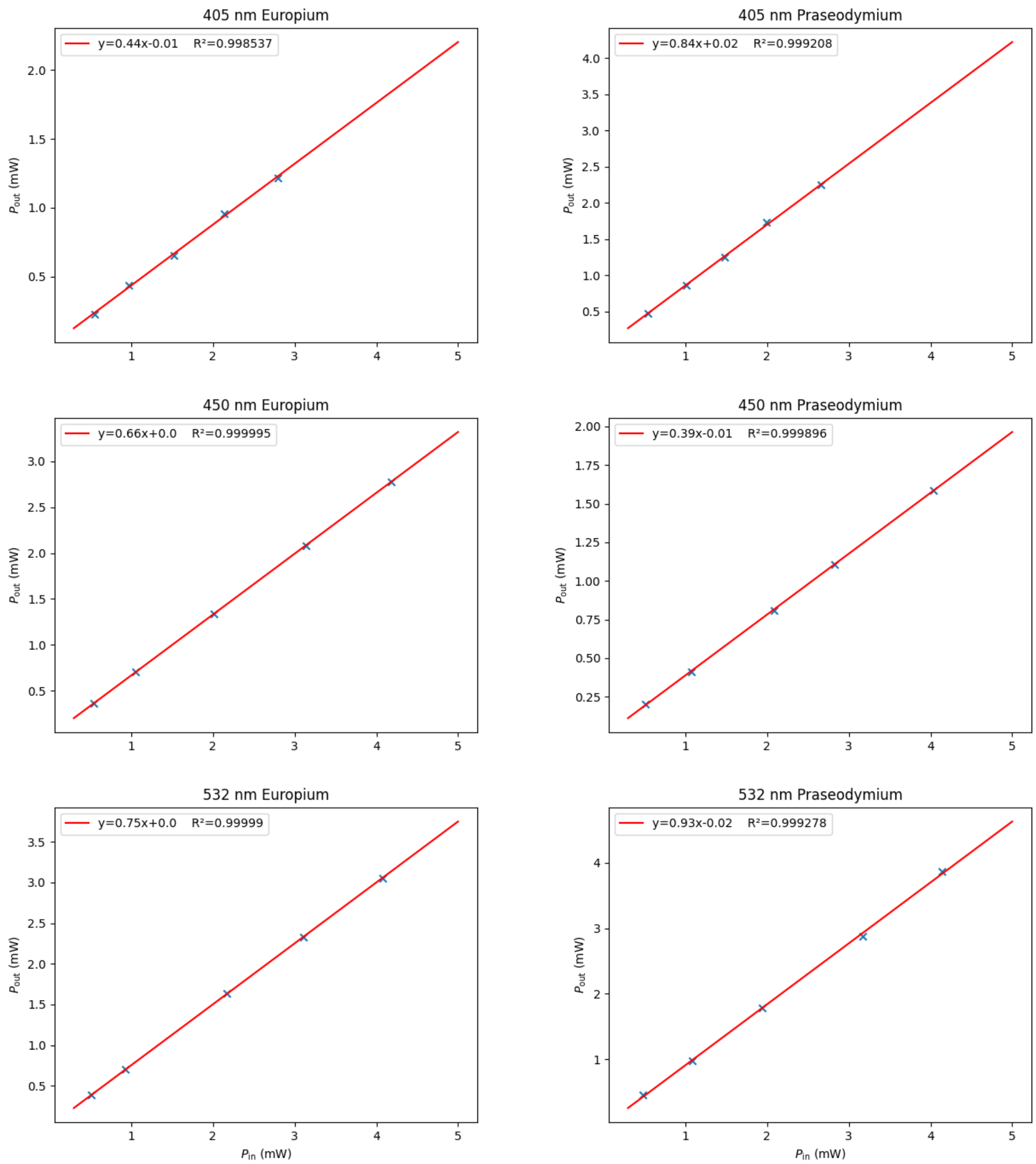
Contents

1 Experiments

1.1 Measuring the reflectance and absorption coefficient using a single beam from a light source.

Task:

You will be given two glass samples doped with rare-each ions (Eu^{+3},Pr^{+3}) and other liquid samples. You are required to find the absorption coefficients for these samples at $\lambda = 405\ nm$, $450\ nm$, $520\ nm$, $635\ nm$ and $670\ nm$. Again, you need to measure the input and output powers in each case for at least 5 different input powers. The input power can be obtained by using an attenuator in front of the laser before it impinges on the sample. Make sure that the incident beam is normal to the sample surface. You may need to place the sample on a tip-tilt stage to be able to do that. When you plot the output powers vs. the input power, you can determine α from the slope once you know R.



Knowing that the formula for input vs output power is:

$$P_{\text{out}} = P_{\text{in}}(1-R)^2 e^{-\alpha L}$$

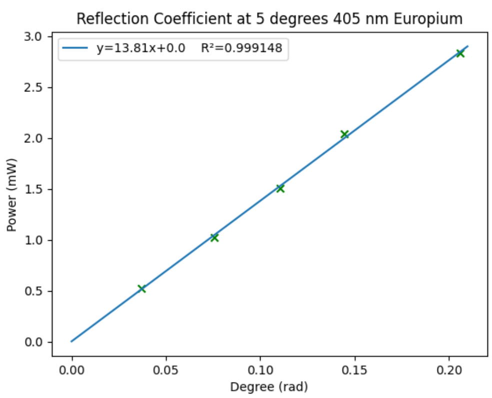
And knowing that our Europium sample was 0.330 cm thick and our Praseodymium sample was 0.465 cm thick, we can calculate α because the slopes on the plots will be $(1-R)^2 e^{-\alpha L}$ and thus

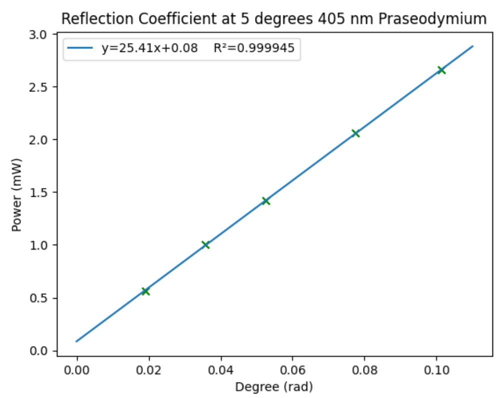
$$\alpha_{\text{Eu}} = -\frac{\log\left(\frac{\text{slope}}{(1-R)^2}\right)}{0.0033} \qquad \alpha_{\text{Pr}} = -\frac{\log\left(\frac{\text{slope}}{(1-R)^2}\right)}{0.00465}$$

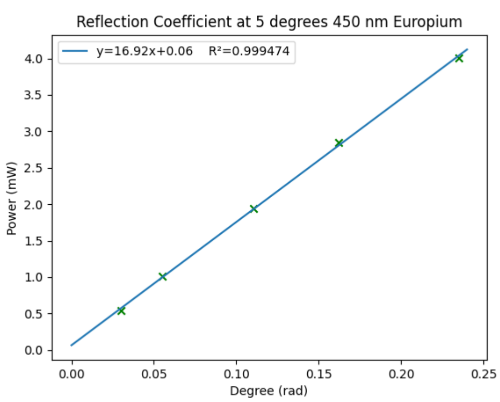
Task:

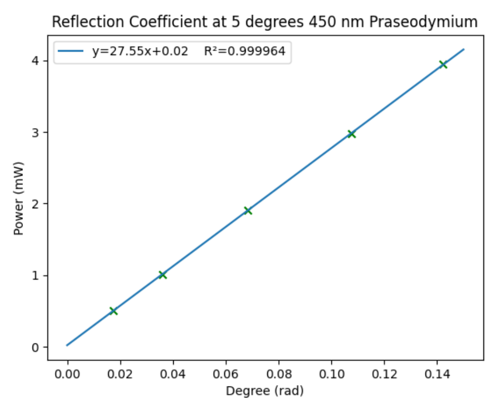
Measure the reflection coefficient at 5 degrees for the wavelengths used in part a). Be sure to use at least 5 different input powers. Then find R from the plot of reflected power vs. incident power.

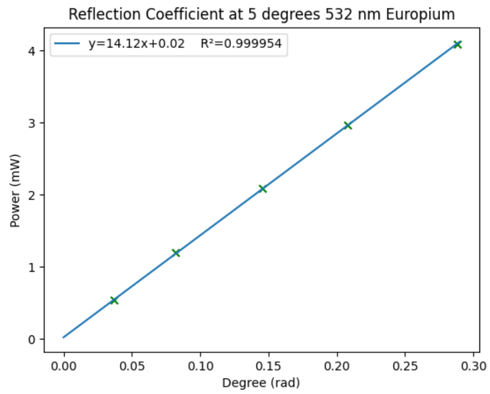
From the plots we can get the different values for R on the slopes of the linearizations. To obtain the value of the transmission coefficient, we simply subtract 1 from the R value. To obtain alpha, as previously explained, we have to calculate with the previously provided formula. The results can be observed on the following table.

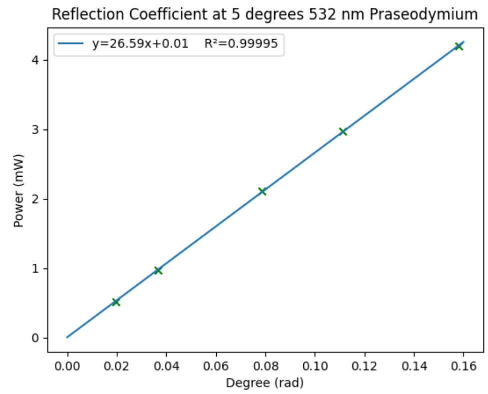












Final Data	532 nm		450 nm		405 nm	
	Eu	**Pr**	**Eu**	**Pr**	**Eu**	**Pr**
α (cm^{-1})	0.4306	0.0082	0.8790	1.8579	2.0454	0.1840
R	0.0708	0.0376	0.0591	0.0363	0.0723	0.0393
T	0.9292	0.9624	0.9121	0.9637	0.9277	0.9807

Task:

Try to directly measure the reflectance at normal incidence using a beam splitter. In this case you need to find the transmission and reflection factor for the beam splitter to be able to find the absolute reflectance.

The measured incident power was of $2.87mW$ and the reflected was of $0.333mW$. Thus $R = {}^{0.333}/_{2.87} = 0.115$ or 11.5%

For the sample, te power measured was $40.5\mu W$ residual and $63.8\mu W$ in total. Then the true power was $63.8 - 40.5 = 23.3\mu W$

For the mirror the reflection at very low angle with a mirror measured a power of $2.087mW$. The residual measured was $42\mu W$ and the total was of $157.3\mu W$. Then the true power was of $157.3 - 42 = 115.3\mu W$

Finally, R can be calculated:

$$R = \frac{2087}{115.3} = 0.181 = 18.1\%$$

2 Addenda

LaTeX code that generates this document

PHOTONICS-LabRep5:absorption.tex

Python code that generates the plots and contains the data

PHOT-E3.py