

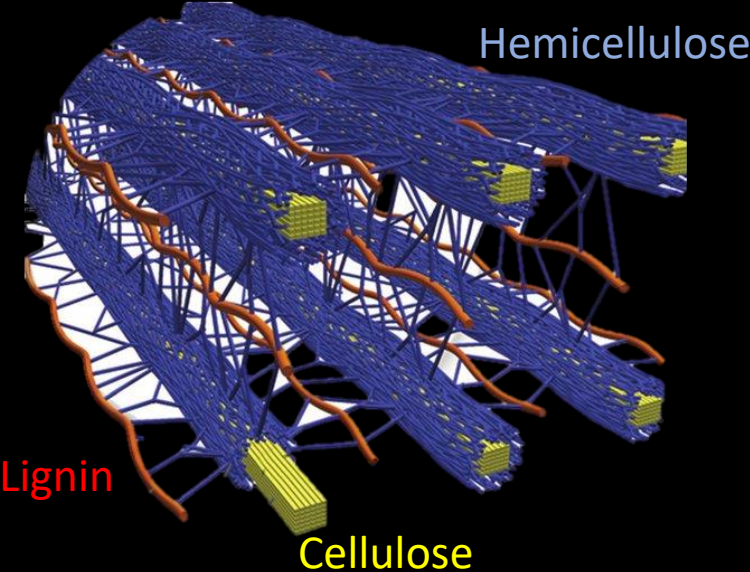
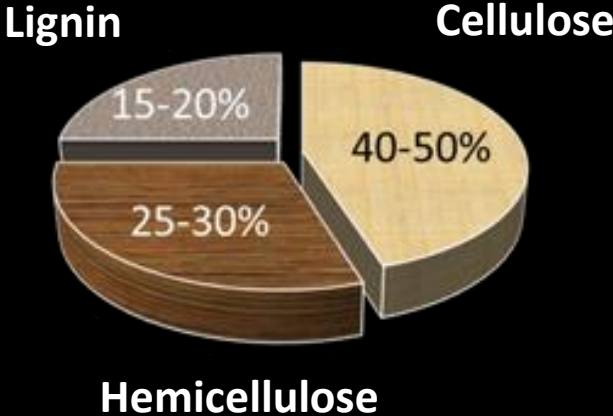
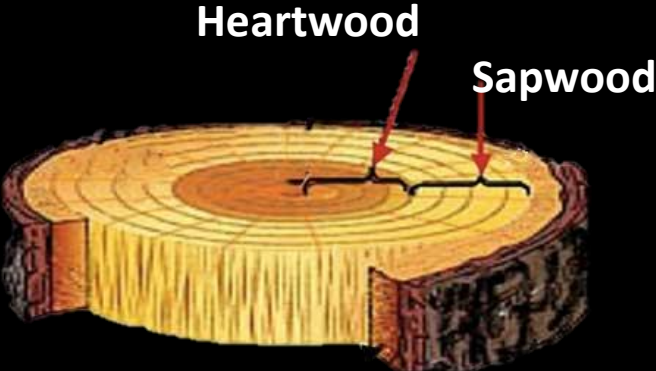
WOOD●●

OPTICAL CHARACTERIZATION
OF TRANSLUCENT WOOD

Ashima Vashistha

30.05.2022

Anatomy of Wood

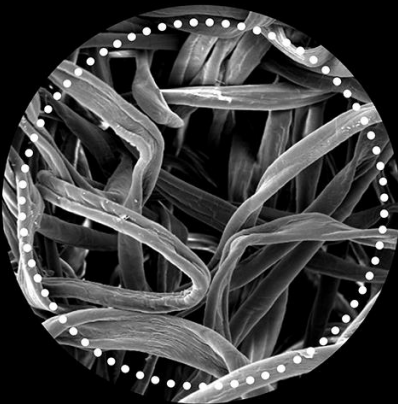


Woodoo Process



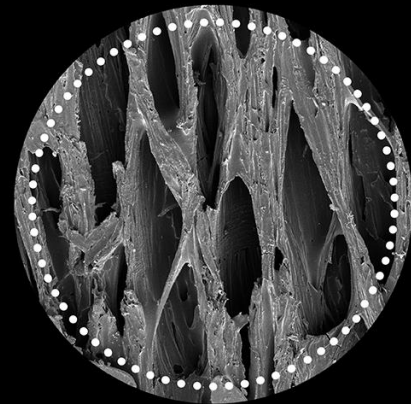
wood

-



lignin

+



specialty polymer

=



WOODOO

CAR INDUSTRY

Global shortage of steel

+100% PRICE INCREASE IN 2017³

CHINA = 46% OF GLOBAL STEEL DEMAND IN 2018⁴

TOP STEELMAKERS LACK RAW MATERIALS⁵

GLOBAL STEEL DEMAND GROWTH +16% IN 2018⁶

CONSTRUCTION INDUSTRY

Global shortage of sand

SAND +600% PRICE INCREASE SINCE 1995⁷

CHINA 2011-2013 > USA 20TH CENTURY⁸

MORE EXTRACTED THAN OIL⁹

70% URBAN POPULATION BY 2050¹⁰

Woodoo Products



●● SLIM™

Electronics stack up



- Tactile surfaces & interfaces
- Display Panels



●● SWITCHR™



●● JASPR™

OUR KEY MARKETS

CONSUMER

AUTOMOTIVE

CONSTRUCTION

44 AWARDS

INSTITUTIONAL



French Prime Minister



French Energy Agency



French Ministry of the Environment



French Ministry of Research



French Ministry of Agriculture

INTERNATIONAL



SME Instrument - Phase 2



European Innovator of the year 2016



EC Flexible electronics



EC SME Associate



World Economic Forum - Global Shaper

NATIONAL



CNAM material Grand Prize



PRI Industrial grant



FrenchTech National Prize



1st Prize - Great East Region



1st Prize - Paris City Council

CORPORATE



1st Prize - Real Estate



1st Prize - TOTAL Energies



World Alliance Award



LVMH Award



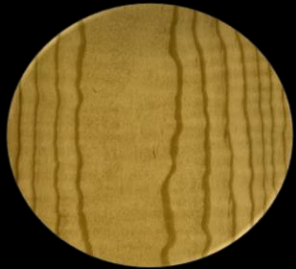
1st Prize - EDF Pulse

Optical Characterization Objective

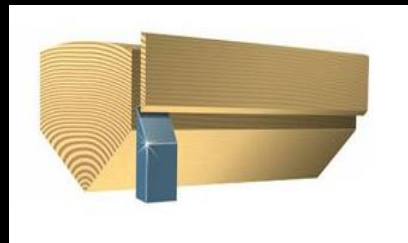
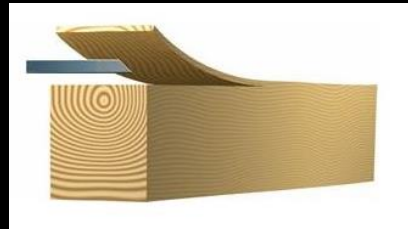
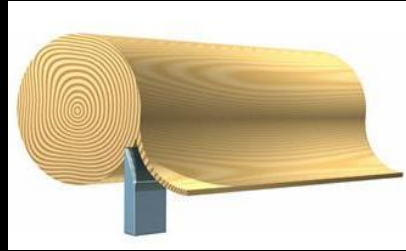
Define	Discover	Develop	Enhance
<ul style="list-style-type: none">• Optical properties to consider.• Measurement methods.	<ul style="list-style-type: none">• Degrees of freedom<ul style="list-style-type: none">• Innate properties• Chemical processes• Growth conditions	<ul style="list-style-type: none">• Trends and relation between degrees of freedom and obtained optical properties	<ul style="list-style-type: none">• Enhancing of optical properties based on the trends.

Primary Degrees of Freedom

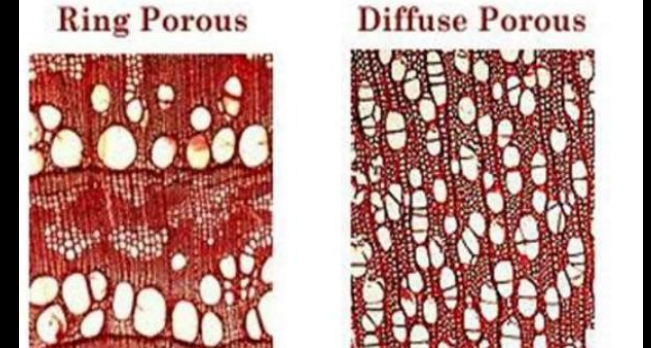
●● Species



●● Cuts



●● Porosity

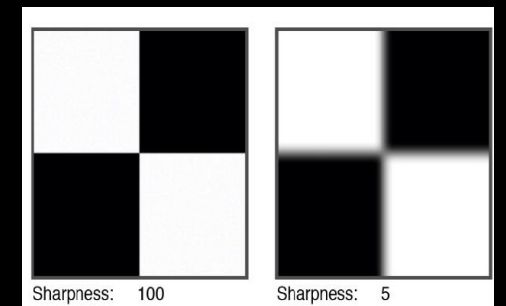
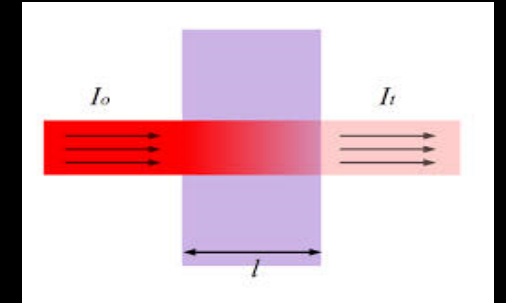


Delignification and polymerization Process



Optical properties of interest

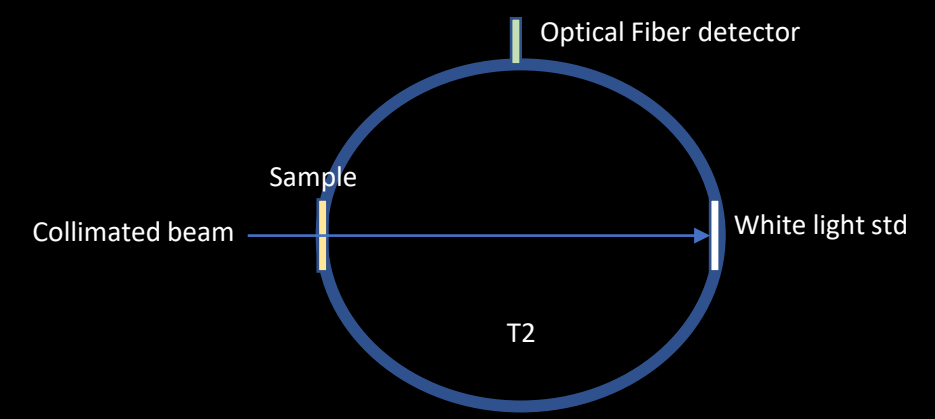
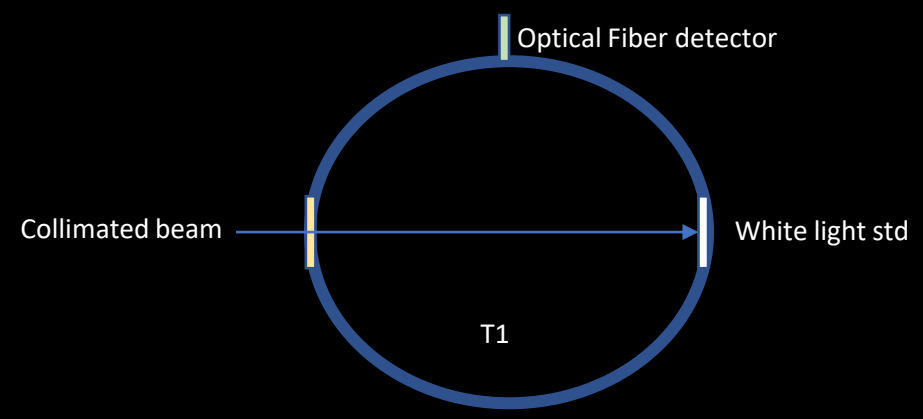
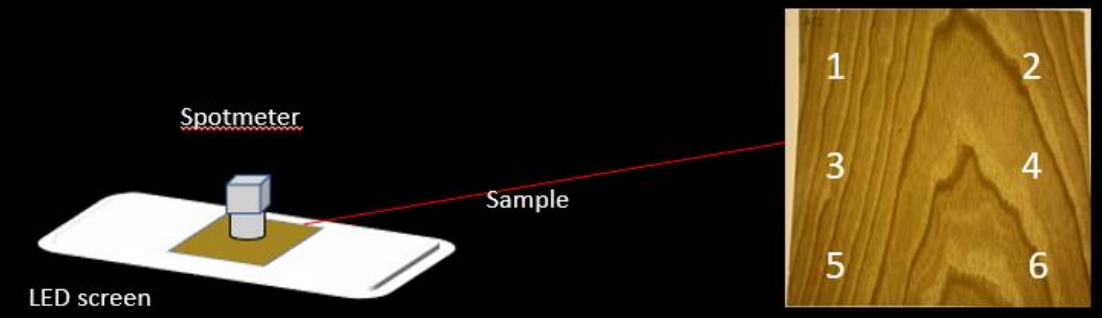
- Transmission
 - Luxmeter
 - Integrating Sphere
- Haze: light scattering due to internal structure and the surface of the material at wide angles
 - Integrated sphere
- Clarity: sharpness of an image when observed from a narrow angle
 - Rise Distance
- (Absorption, Reflection, Colorshift...)



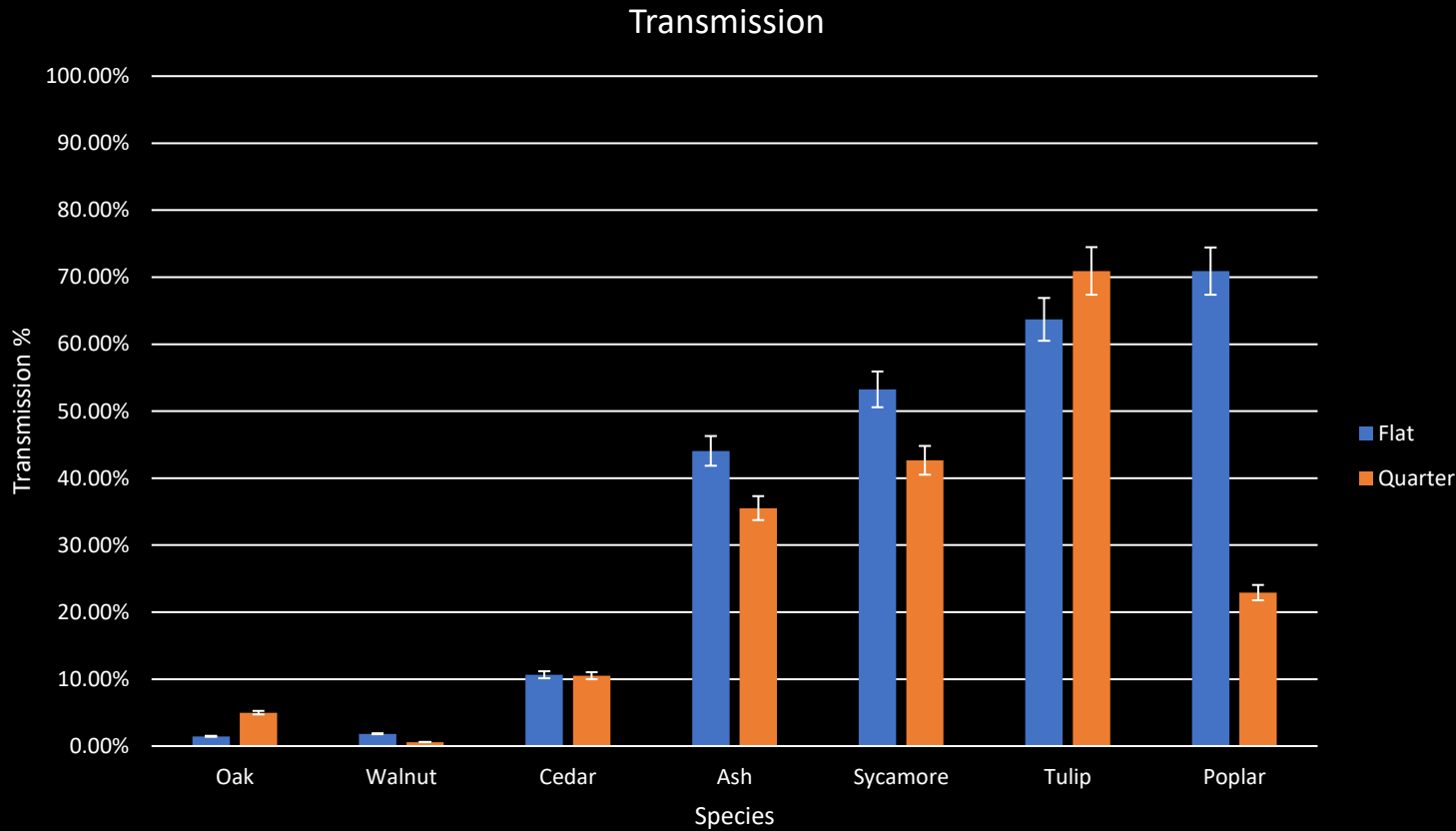
Transmission

- Luxmeter:
 - Contact measurement ($\varnothing 20\text{mm}$)
 - Measuring range 0.01-39990cd/m²
 - Measuring angle <100°

- Integrating Sphere
 - Standard for anisotropic measurements



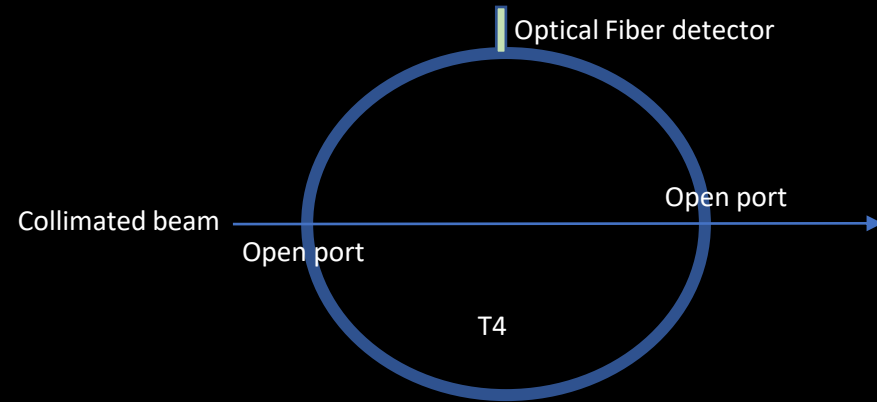
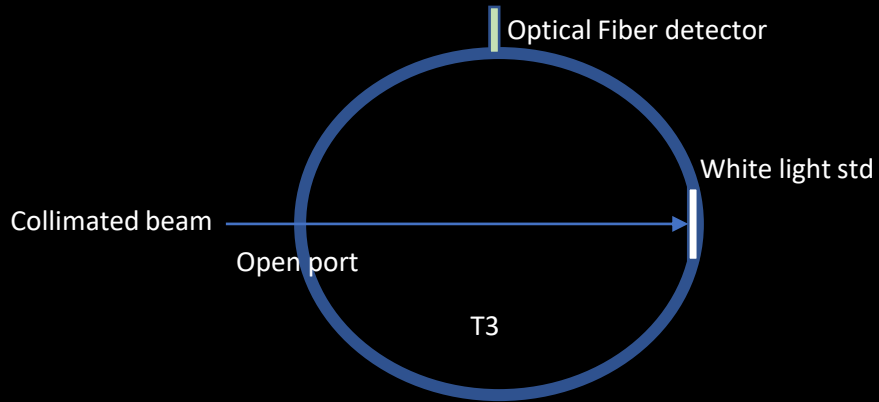
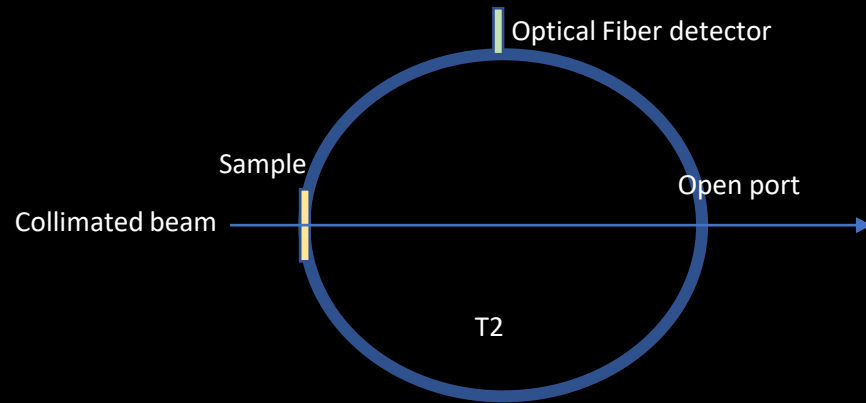
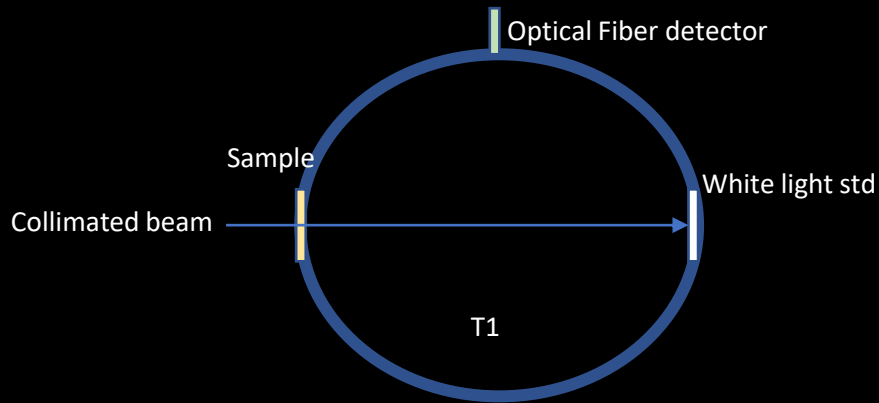
Transmission Results



●● Clear dependence on cuts and the color of the species

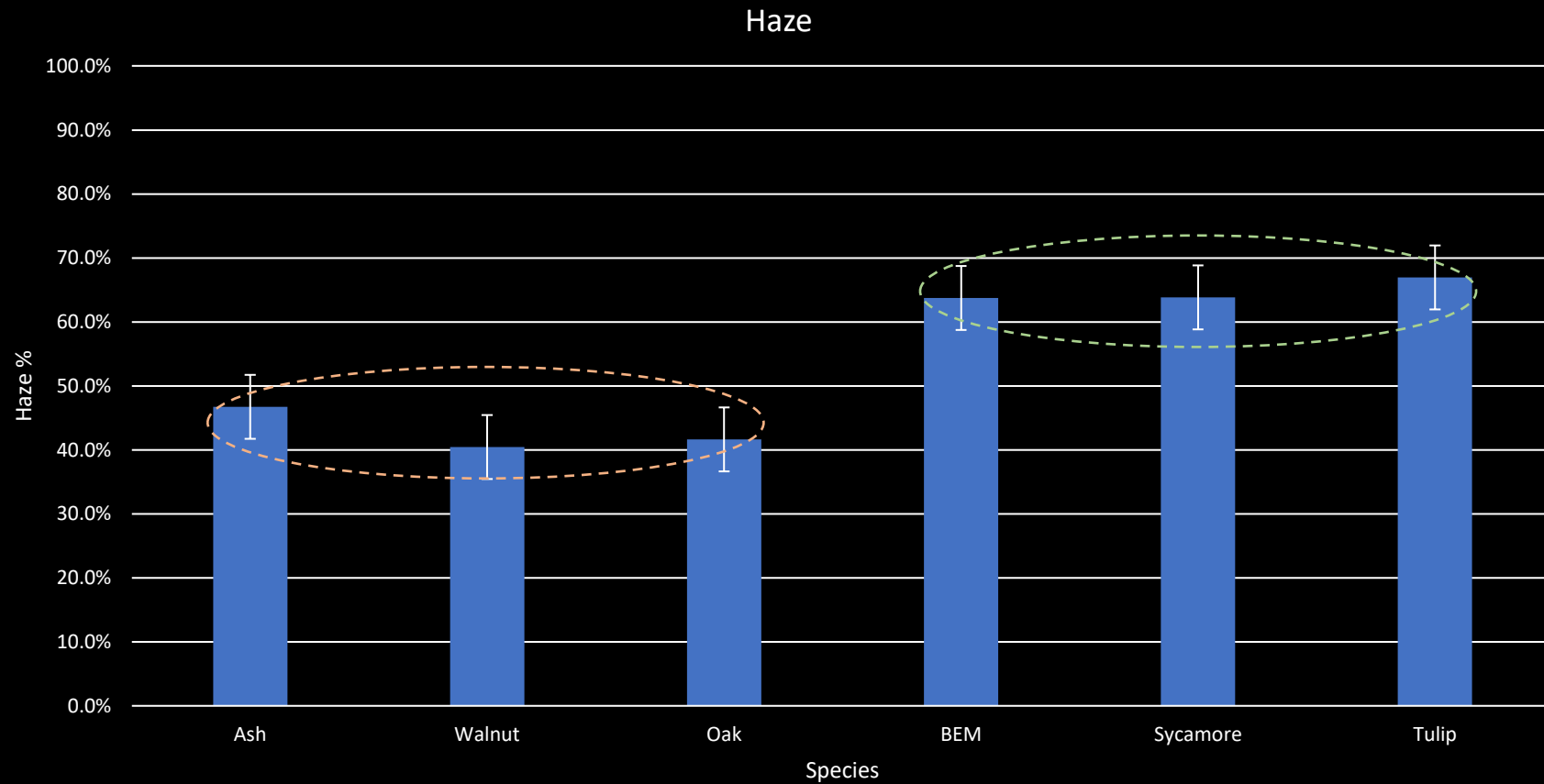
●● Able to achieve up to 70% transmission

Haze



$$H = \frac{T2}{T1} - \frac{T4}{T3}$$

Haze Results

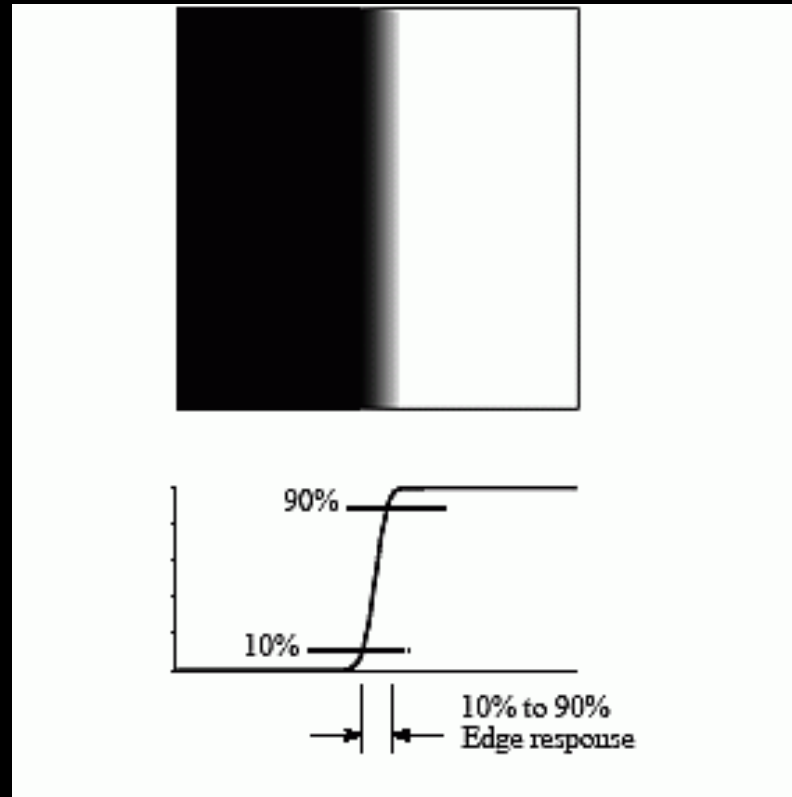


Ring porosity

Diffuse porosity

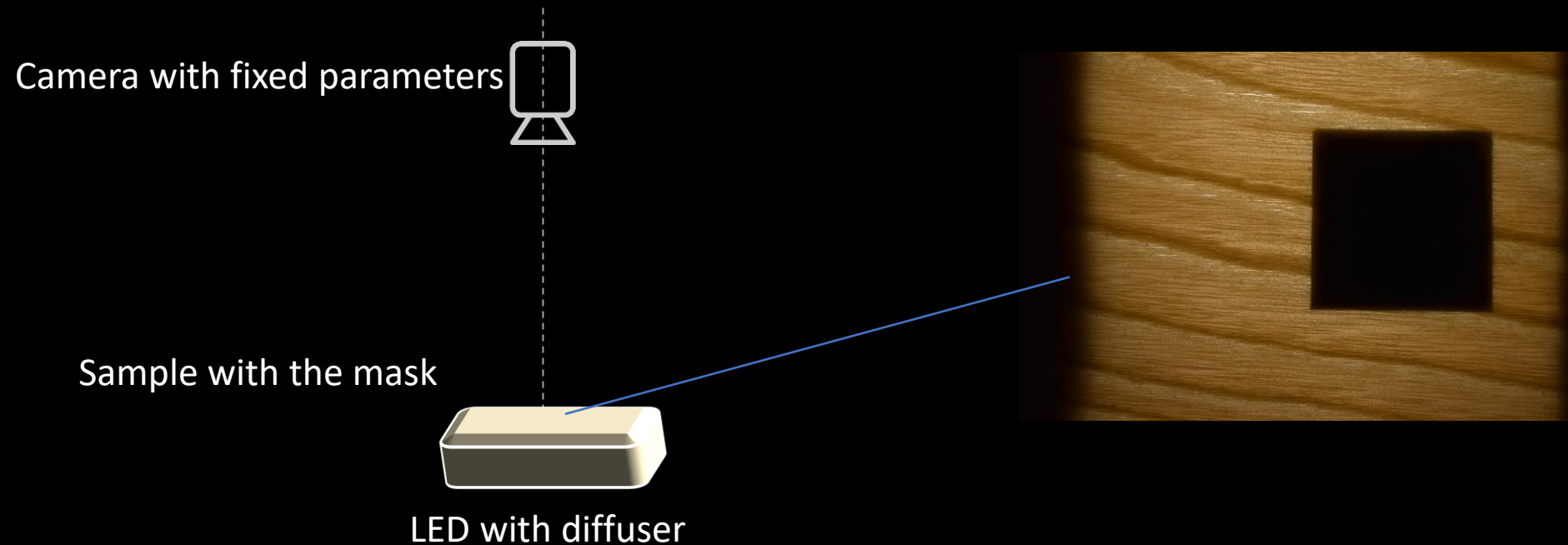
Sharpness

Rise distance: With this technique, sharpness can be determined by the distance of a pixel level between 10% to 90% of its final value when the image of a sharp edge is seen through the material.

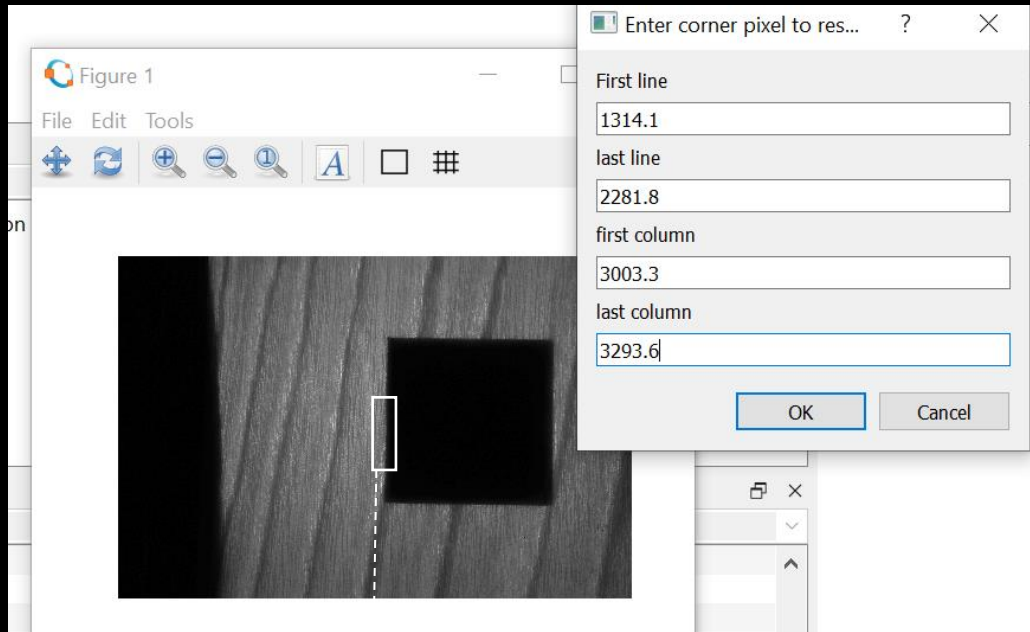


Measurement set up

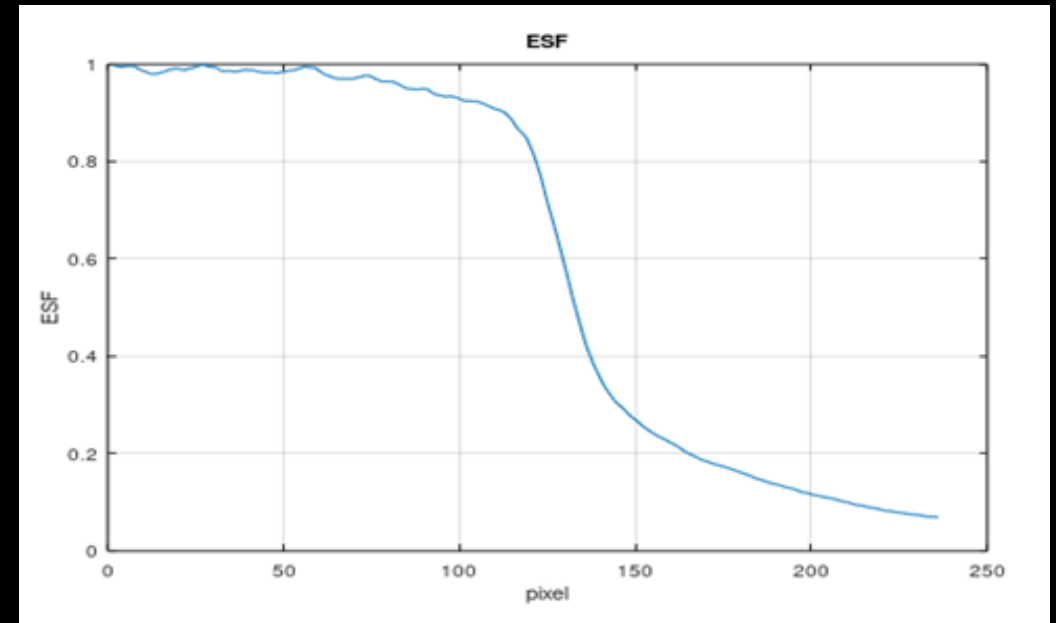
- Set up: all parameters (distance, darkness, set up and camera parameters) were fixed



Generating ESF

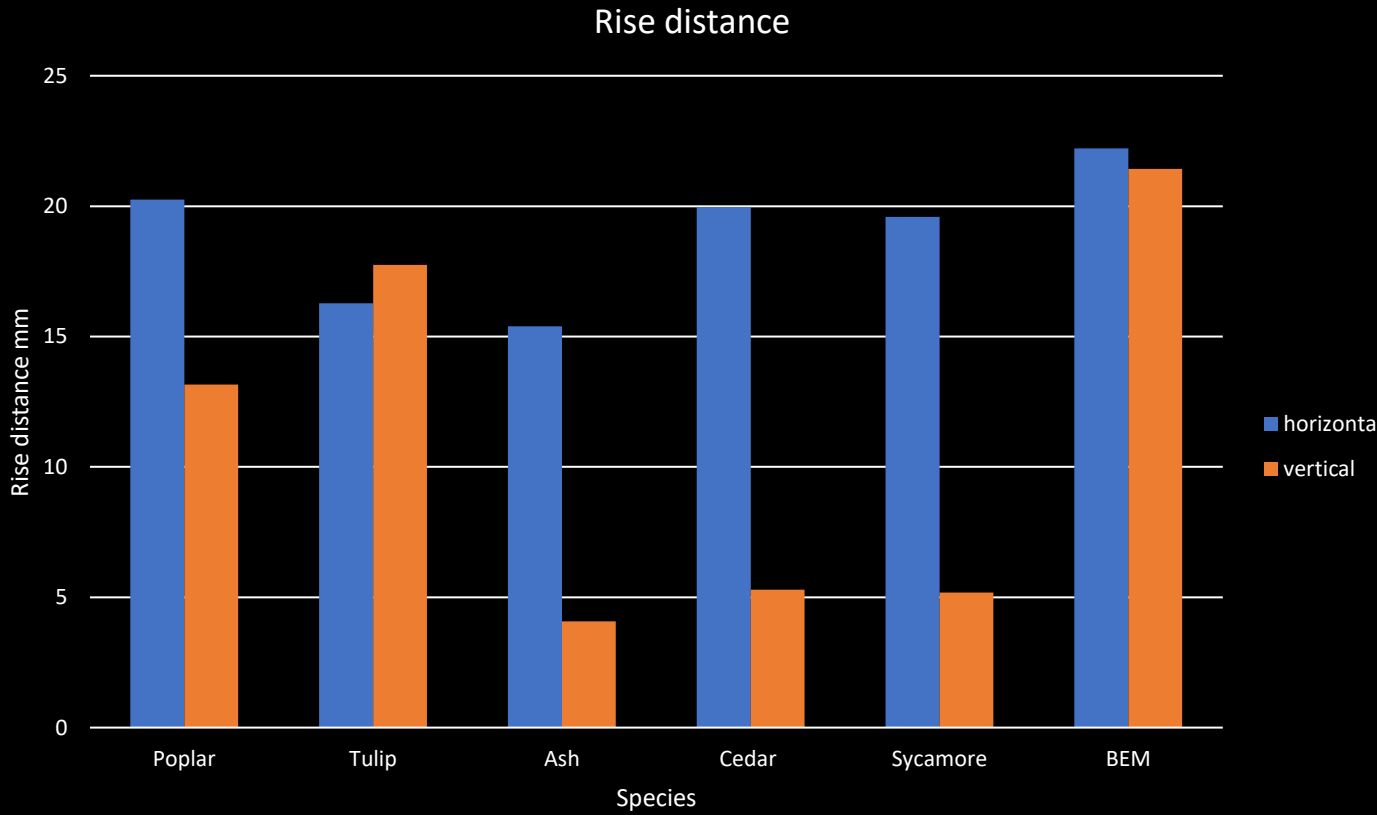


Area of Interest



Rise distance: 98 pxl
25 mm

Rise distance Results



The pattern of the veins affects the rise distance.



Challenges

- Point measurements are not representative of the whole sample.
→ Using global measurements with imaging techniques.
- Pores and grains affects the clarity measurements.
→ AI or other numerical techniques to separate veins from the mask
- No previously defined standards
→ Opportunity to define our own standards
- Unknown degrees of freedom

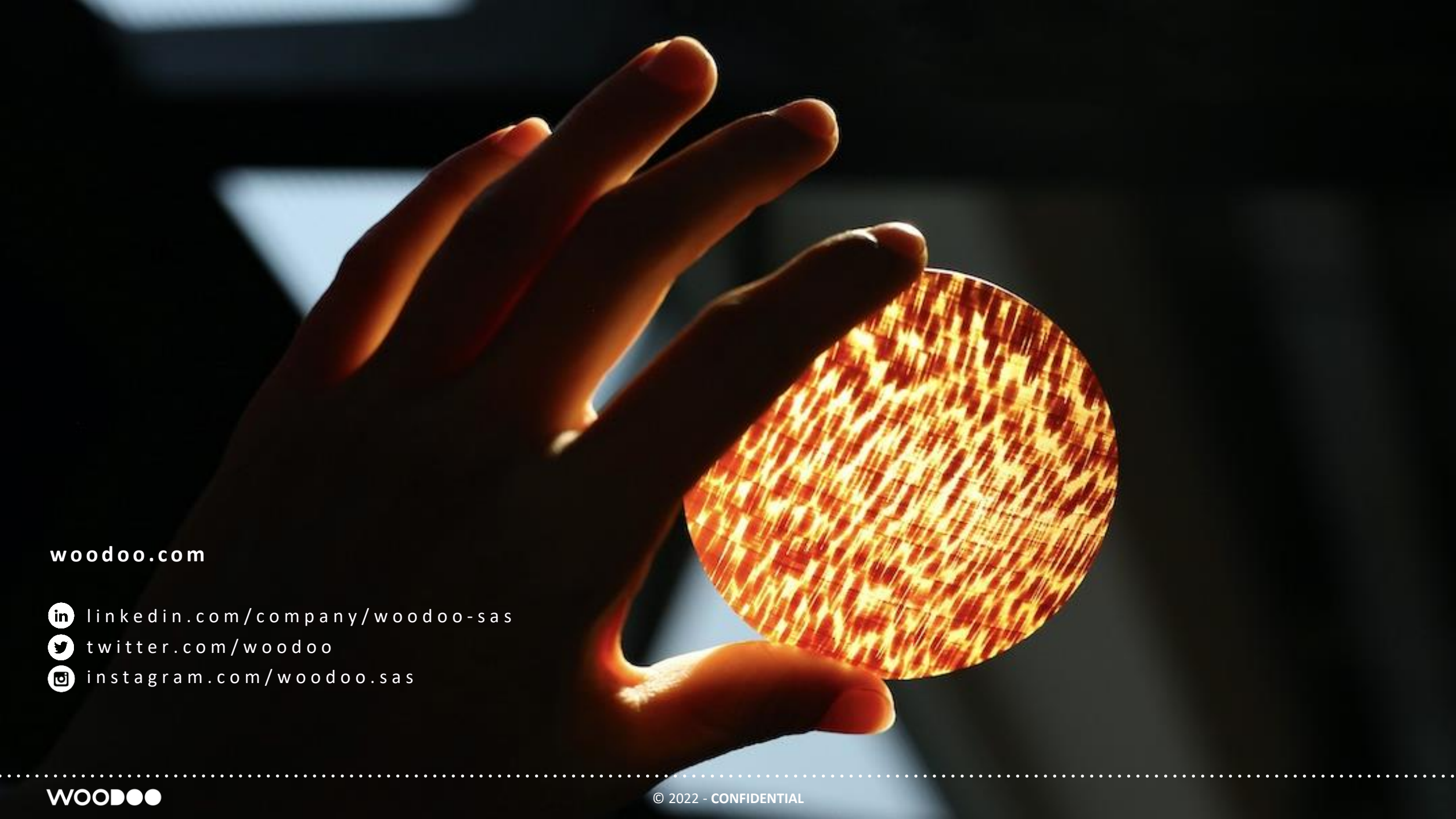


Conclusion


- Deeper understanding of the anatomical structure of wood and its optical properties.
- Finding trends between the optical properties and the innate properties of wood.
- New opportunities to develop new standards for a new product.
- Quantify the analysis of translucent wood using optics and photonics.
- Development of new methodology for optical measurements.


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