Microfluidics for Timber DNA Analysis

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Development and Scaling of Innovative Technologies for Wood Identification

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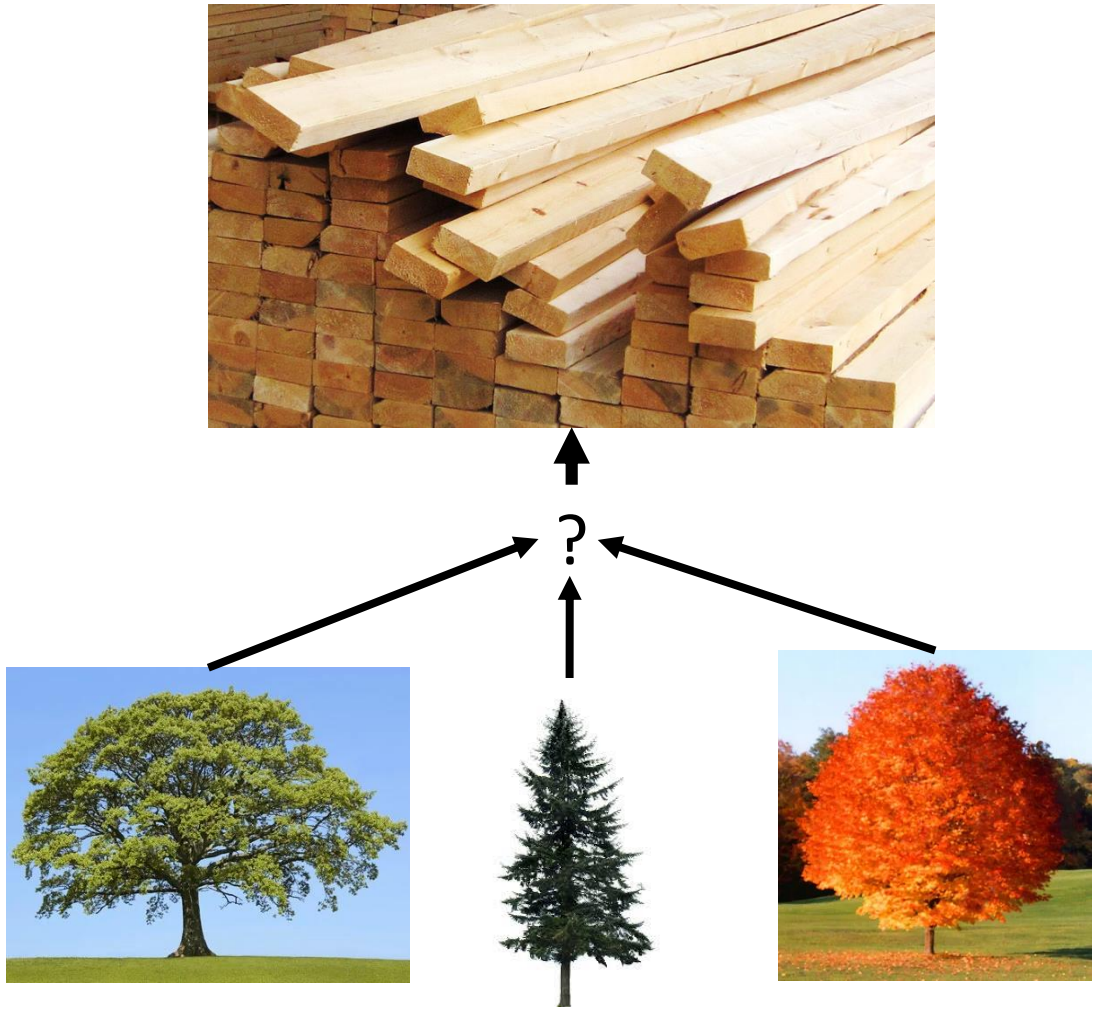
DNA Amplification Test for Timber ID



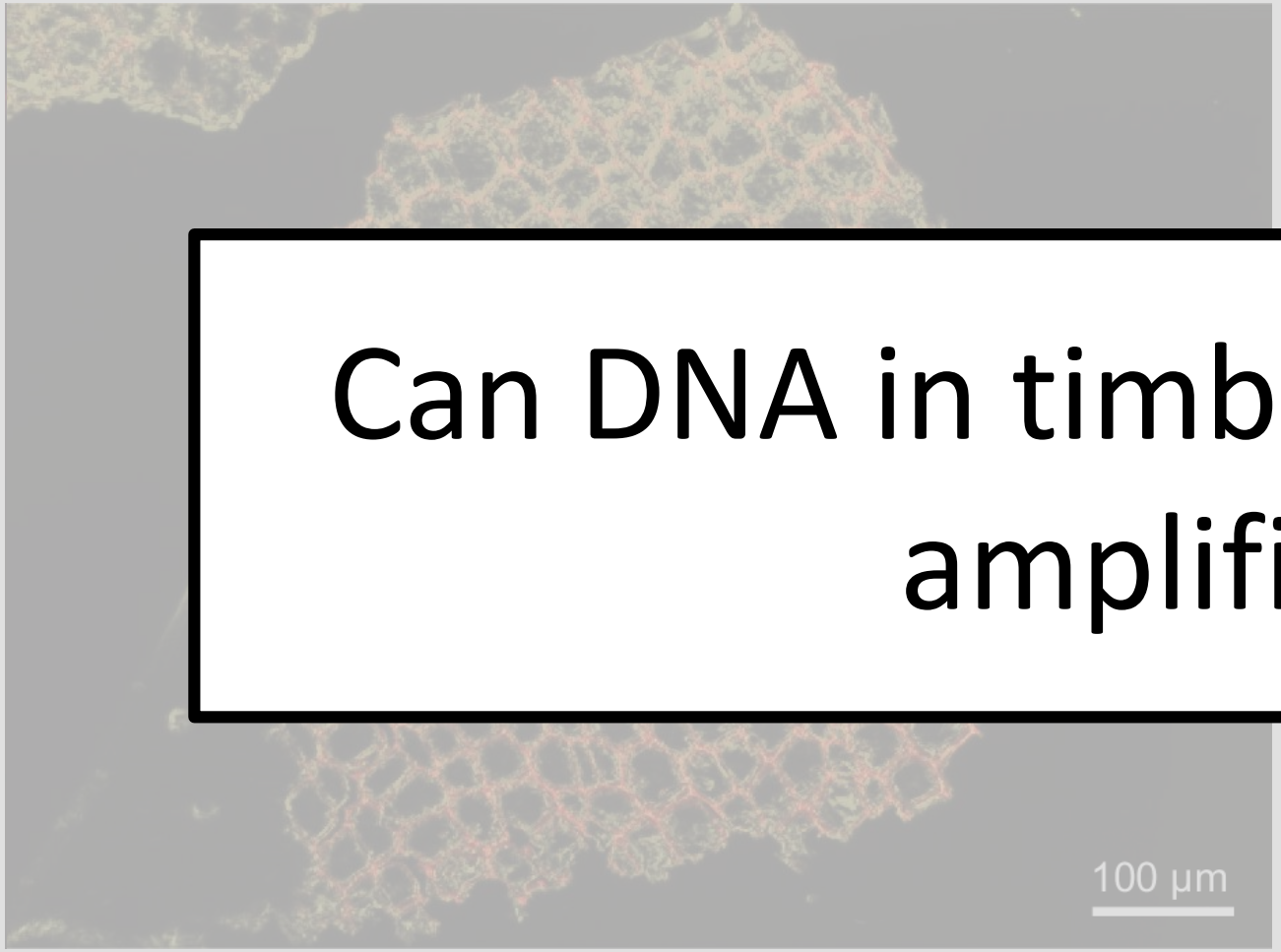
Why use a DNA amplification test?

- High specificity
- Low limit of detection

Challenges for timber DNA amplification

- Need DNA
- Need clean DNA

Timber DNA



Most timber cells are dead

walls

Can DNA in timber samples be amplified?

Traditional Timber DNA Extraction

DE GRUYTER Holzforschung 2015; 69(8): 925–931

Lichao Jiao[a], Xiaoli Liu[a], Xiaomei Jiang and Yafang Yin*

Extraction and amplification of DNA from aged and archaeological *Populus euphratica* wood for species identification

Molecular Ecology (1999) **8**, 2137–2140

SHORT COMMUNICATION

Amplification of oak DNA from ancient and modern wood

S. DUMOLIN-LAPÈGUE,*‡ M.-H. PEMONGE,* L. GIELLY,† P. TABERLET† and R. J. PETIT*

**Laboratoire de Génétique et Amélioration des Arbres Forestiers, INRA, BP 45, F-33611 Gazinet Cedex, France, †Laboratoire de Biologie des Populations d'Altitude, CNRS, UMR 5553, Université Joseph Fourier, BP 53, F-38041 Grenoble Cedex 9, France*

Plant Molecular Biology Reporter **24:** 45–55, March 2006
© 2006 *International Society for Plant Molecular Biology. Printed in Canada.*

Commentary

Extraction, Amplification and Characterization of Wood DNA from Dipterocarpaceae

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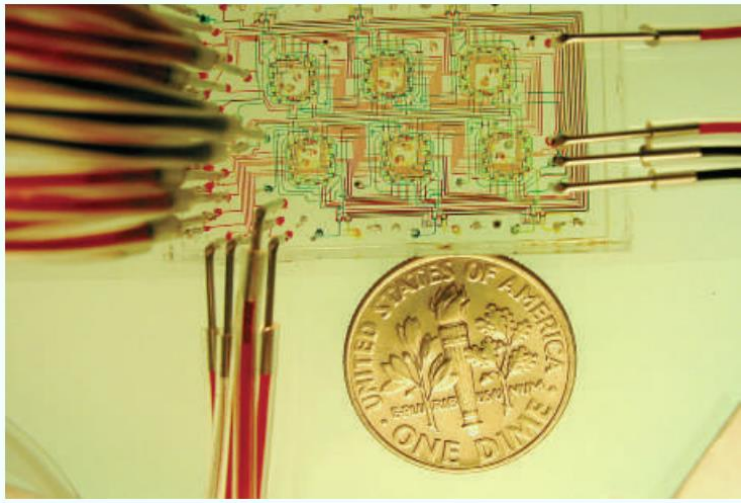
Plant tissue → Plant lysate → Extracted DNA → Separated DNA → Bound clean DNA → Ready-to-use DNA

Not ideal for untrained users

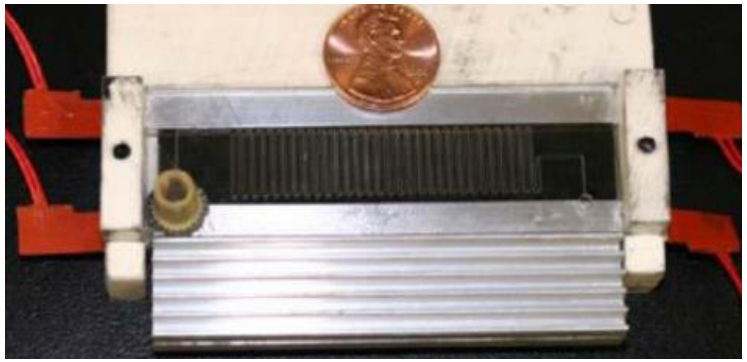
[Qiagen DNeasy Plant Handbook 2015]

Microfluidic DNA Amplification

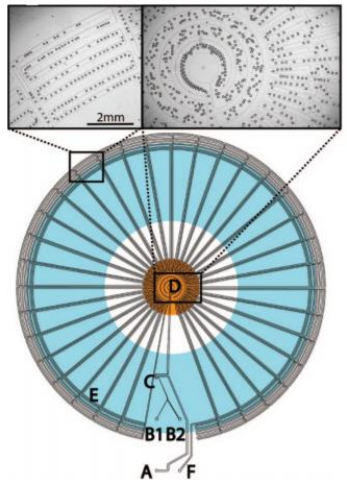


[Whitesides, Nature, 2006]

Microfluidic system:
Any device or method for handling fluids at the microscale



[Crews et al. Biomed Microdevices, 2008]



[Schaerli et al. Anal Chem, 2009]

Microfluidic PCR has been achieved

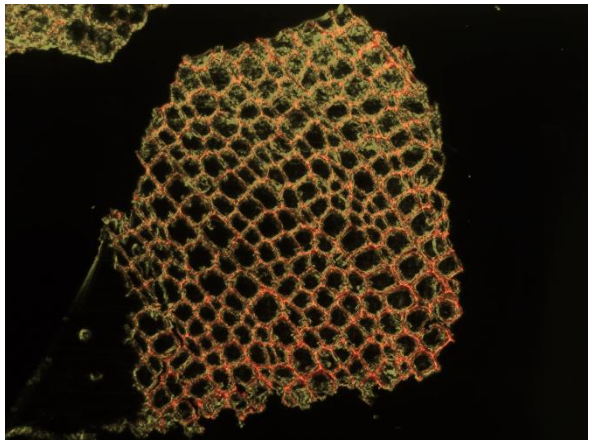
Sample preparation is difficult

Point-of-contact DNA Amplification

Can we apply this approach for timber DNA barcoding?

[LaFleur et al. Lab Chip, 2016]

Enabling a Timber DNA Test



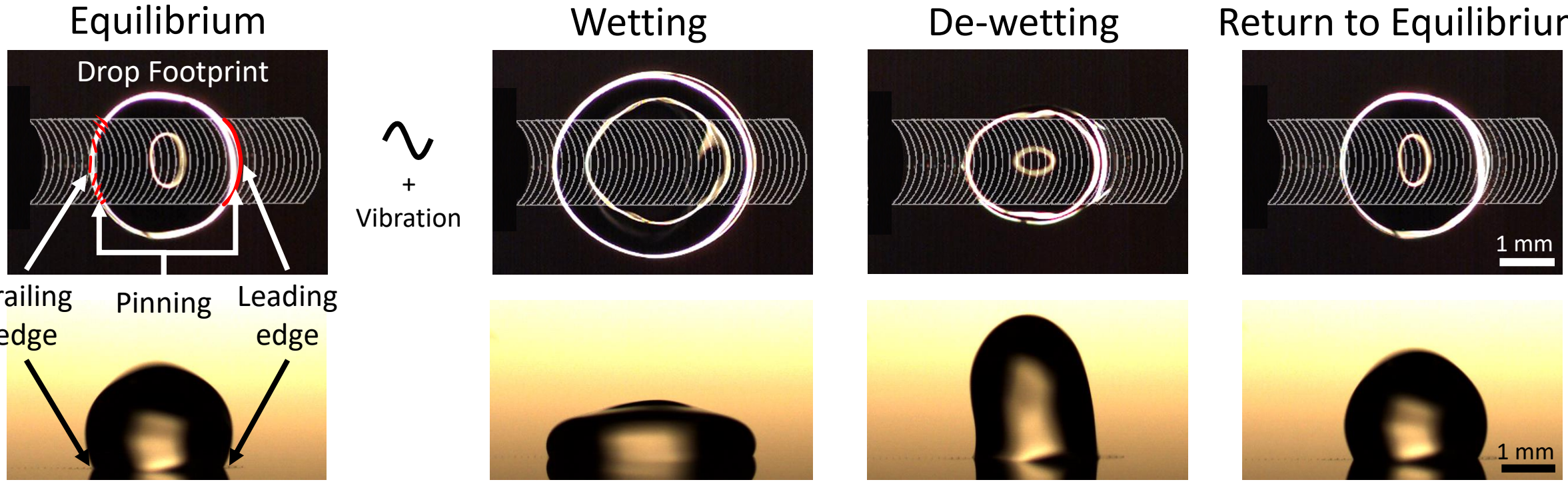
Extract DNA → Purify DNA → Amplify DNA → Detect

Remove inhibitors and nucleases

Add reagents + heat

User Interface

Anisotropic Ratchet Conveyors (ARCs)

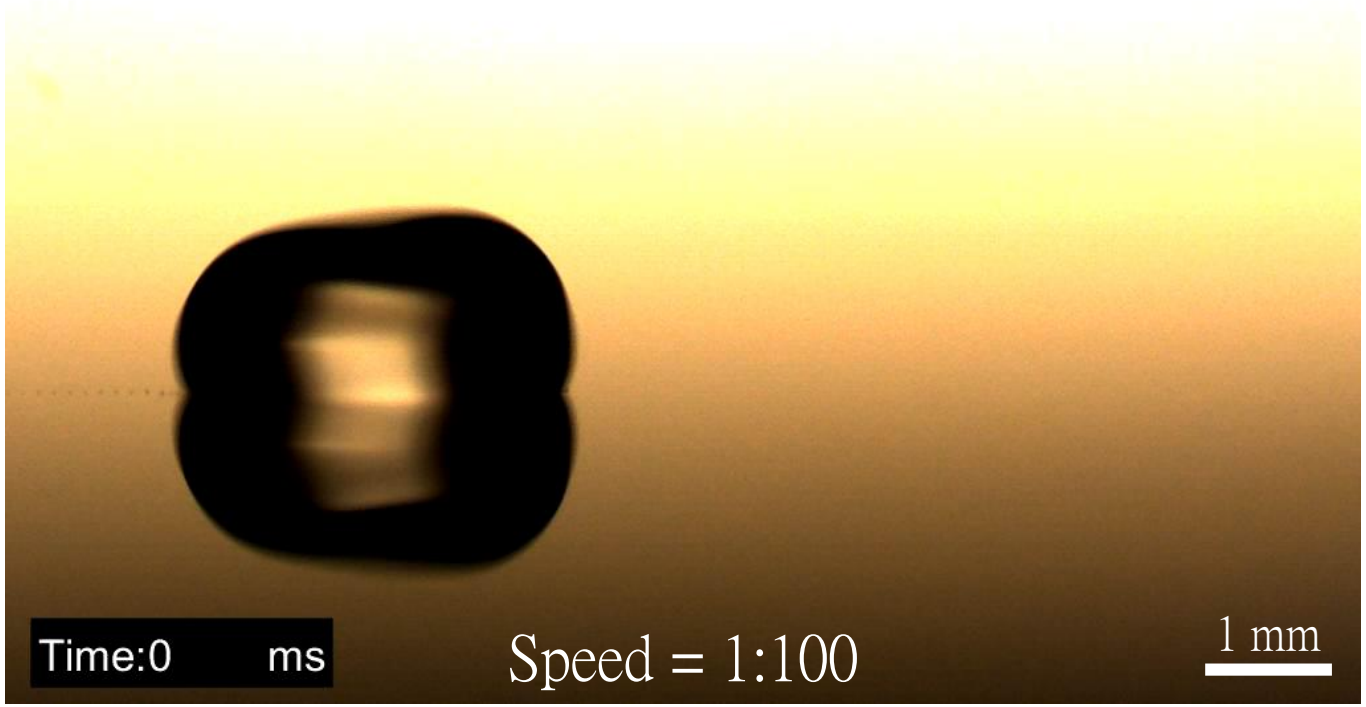


Droplet transport is enabled by two features:

1. Asymmetric surface pattern
2. Orthogonal vibrations

Droplets take a "step" through each vibration cycle

Anisotropic Ratchet Conveyors (ARCs)



ARC advantages:

Smaller sample volume

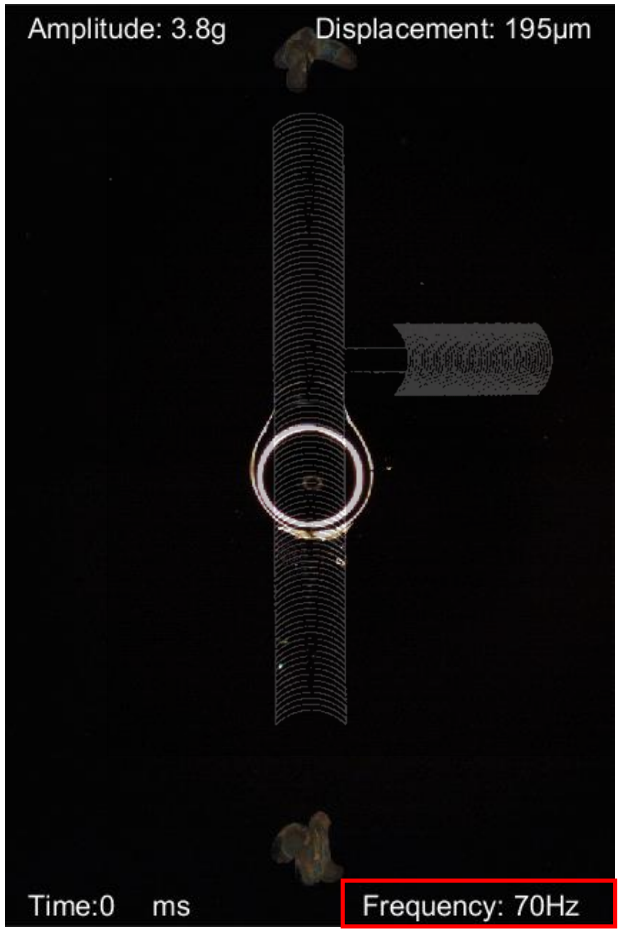
Monolithic fabrication

Programmability

Droplet Switches

Straight

Turn



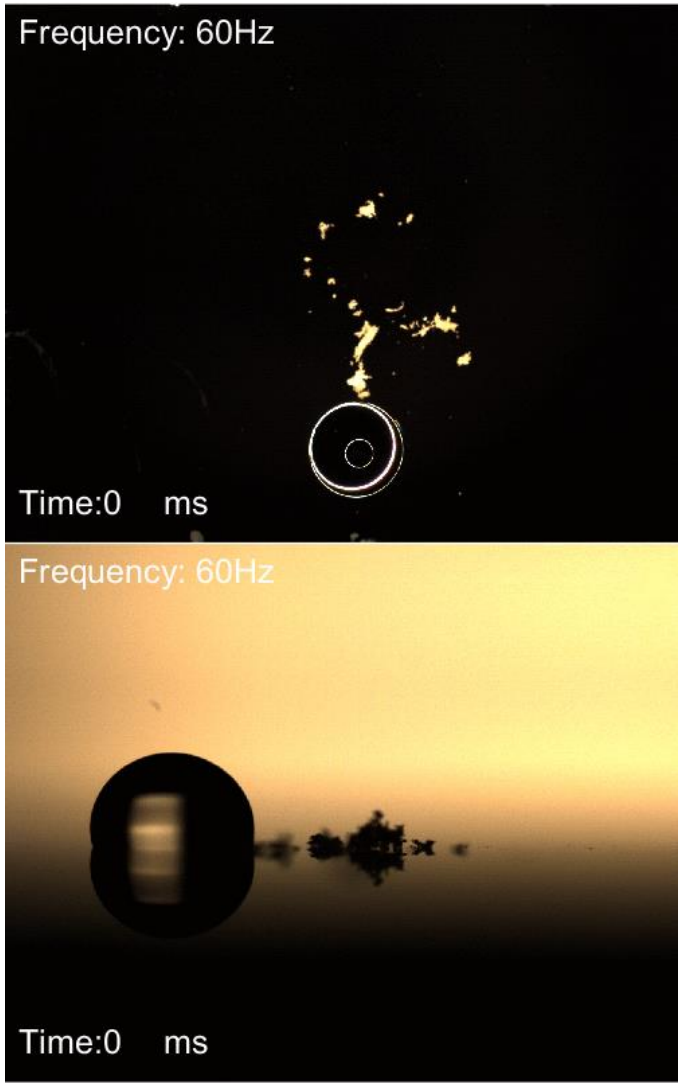
Droplet switch:

Control of directionality

Enabled by ARC design

Response to vibration

Transporting Timber Samples



Droplets on ARCs can transport timber samples (*Pinus Strobus*)

Approach:

Program ARCs to deliver timber samples to DNA amplification modules

Conclusion

DNA amplification tests:

Provide high specificity with low detection limit

Can be performed on timber samples

Goals:

Leverage microfluidic and POC technologies

Enable portable, automated timber ID device

Acknowledgements

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Dr. Karl Böhringer

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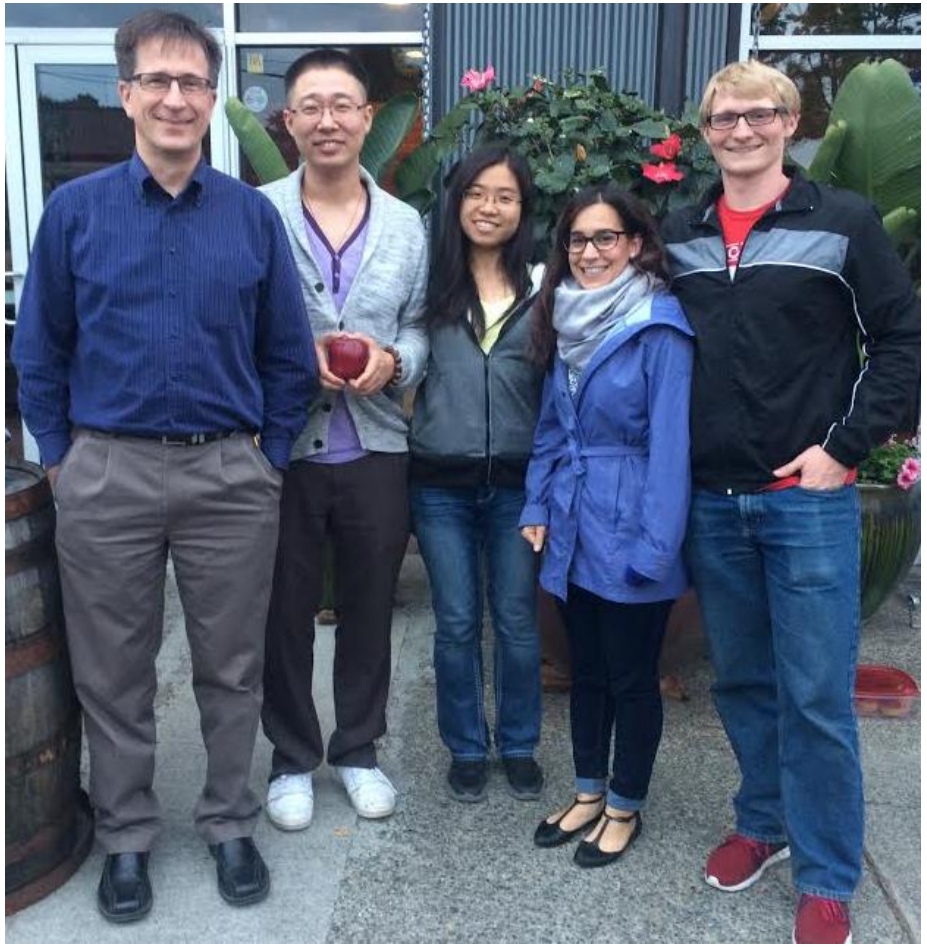
Ana Gomez

CONSERVATION X LABS



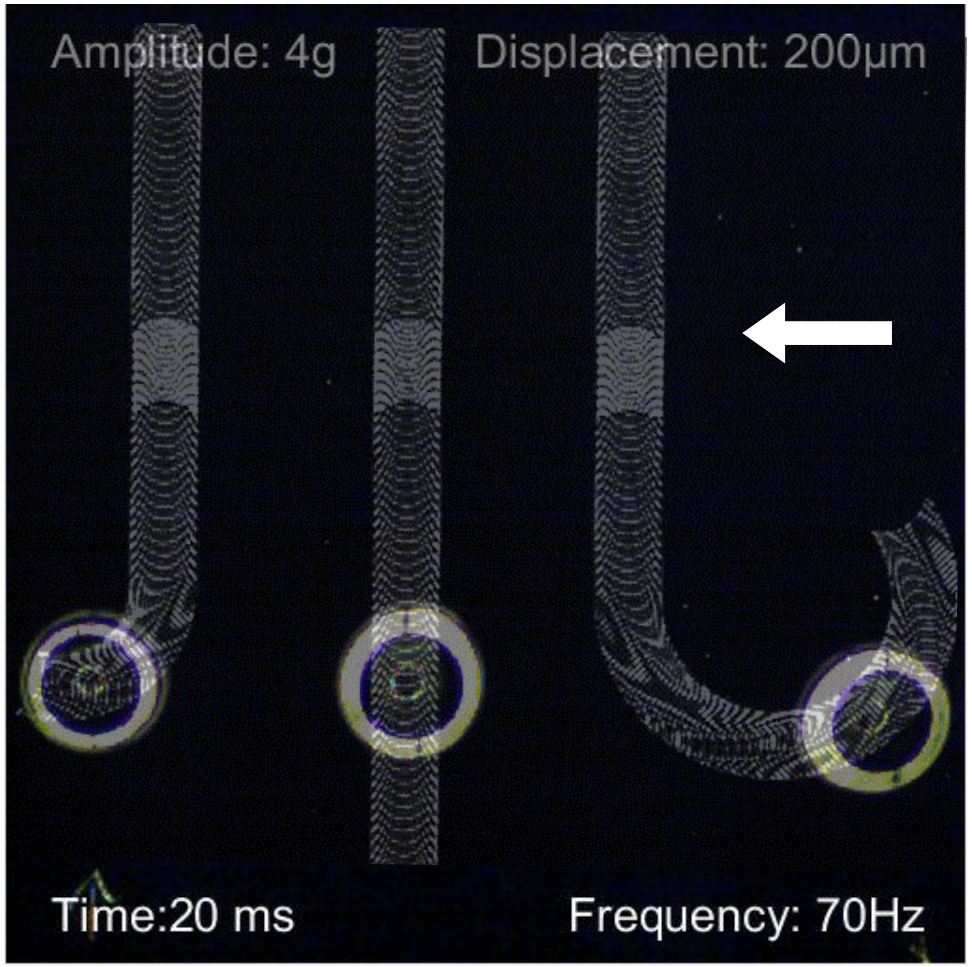
NSF

NDSEG Fellowship

National Nanotechnology Coordinated Infrastructure

Washington Nanofabrication Facility (WNF)

Droplet Gates



Droplet Junctions