Mapping of copper in wood treated with a copper-based preservative and exposed to the copper-tolerant brown rot fungus *Fibroporia radiculosa*

Benoit Duchemin, Normandie University, Le Havre, France

Juliet D. Tang, USDA FS, Forest Products Laboratory, Starkville, MS

Yoshiharu Nishiyama, University Grenoble Alpes, Grenoble, France

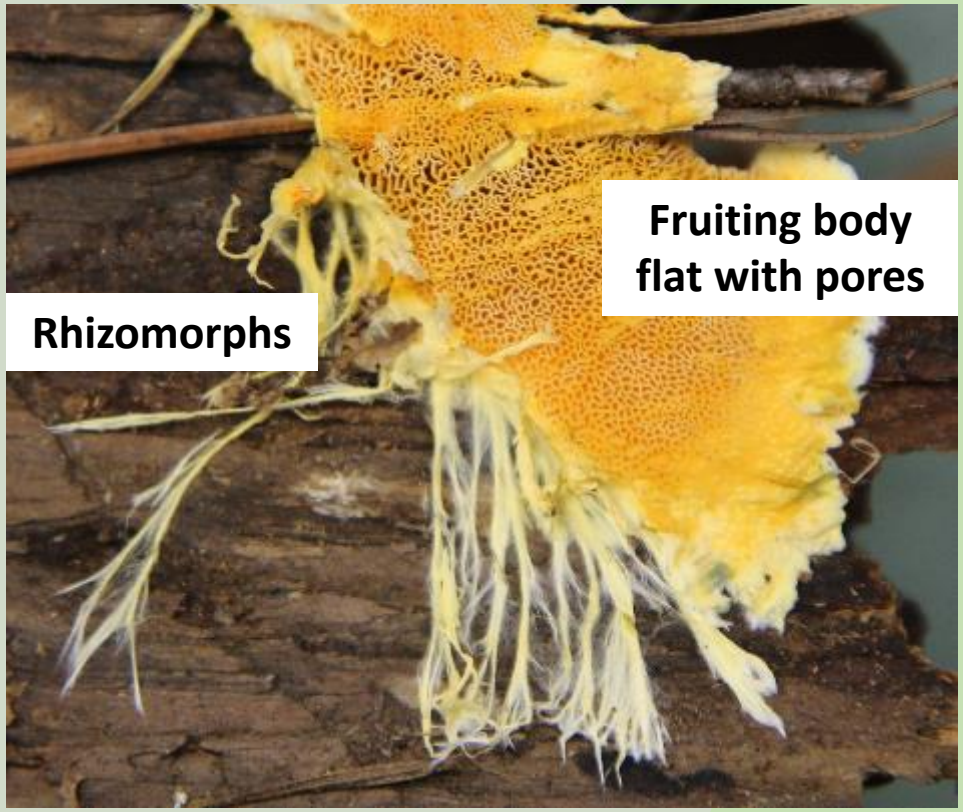
Yu Ogawa, University Grenoble Alpes, Grenoble, France

Solenn Reguer, Synchrotron Soleil, Saint-Aubin, France

Daniel Chateigner, University de Caen Normandie, Caen, France

Darrel D. Nicholas, Sustainable Bioproducts, Mississippi State University, MS

Study Organism – *Fibroporia radiculosa*

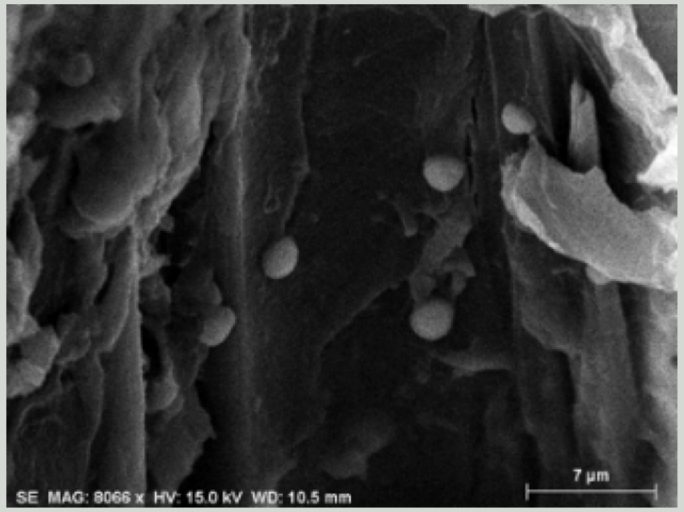


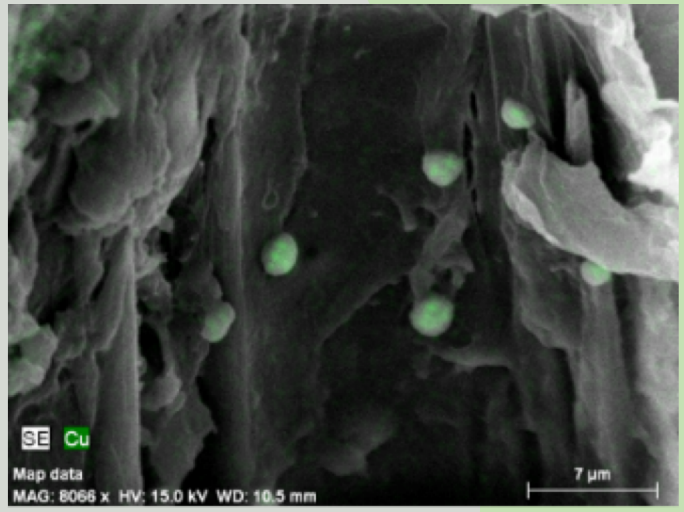
- Brown rot fungus
- Cosmopolitan
- Aggressive decomposer
- Copper tolerant

Mechanism of Copper Tolerance

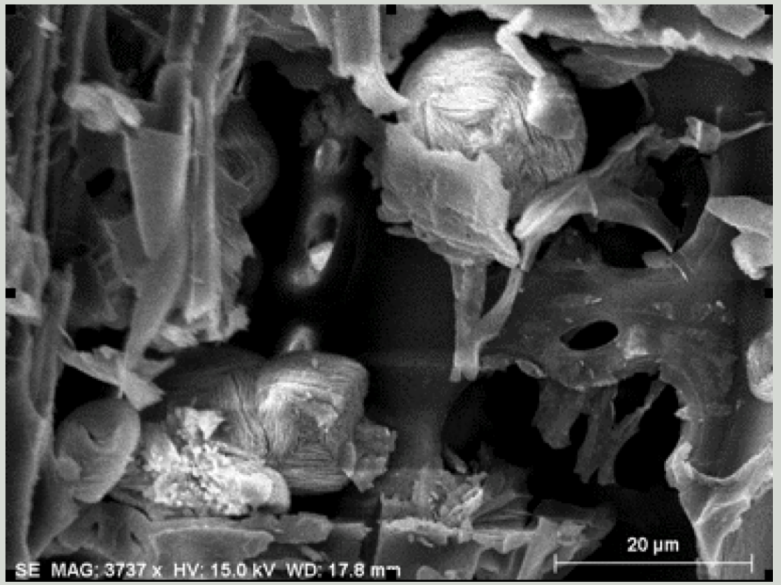
- Pressure-treated wood for residential use
  - ACQ CA MCA
  - all copper-based
- Transforms copper to copper oxalate crystal
  - SEM-EDX images confirms transformation
  - Cu is non-toxic because crystal is insoluble
- Spatial and temporal details?

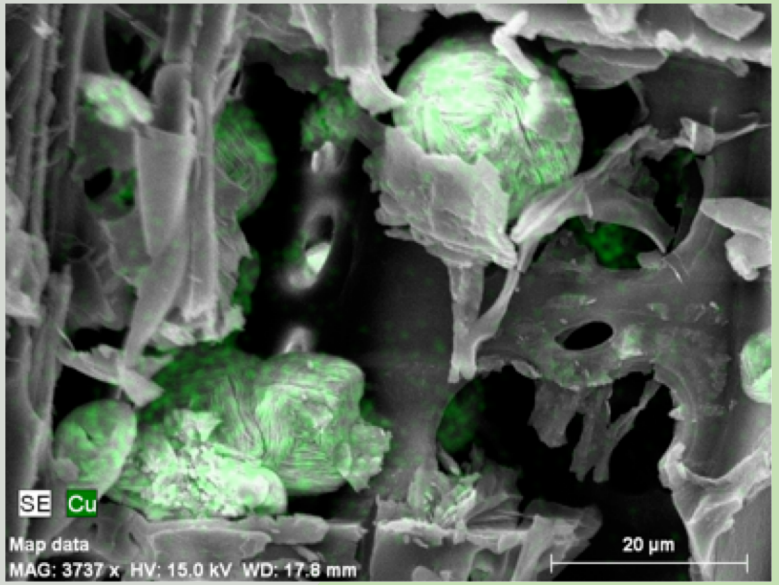
$CuCO_3$
unexposed





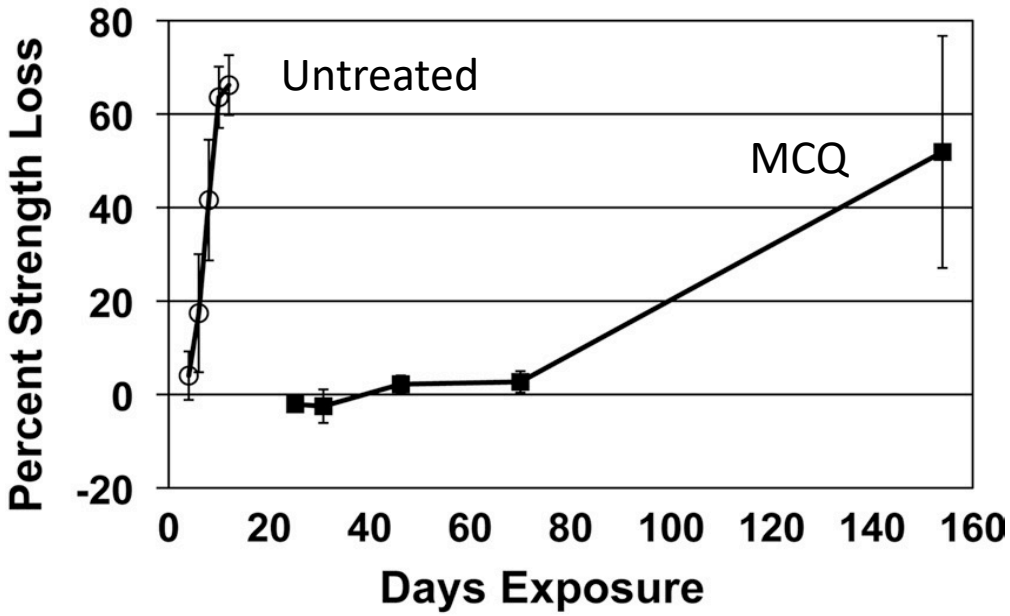
CuC_2O_4
exposed day 154



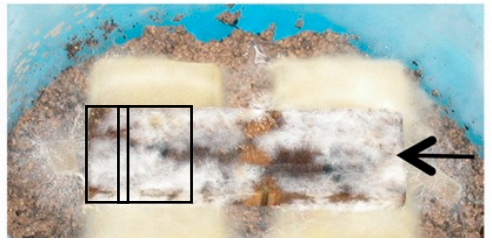


Specimen Treatment and Fungus Exposure

- SYP sapwood wafers
  - 54 x 18 x 5 mm (tang x radial x long)
- Full cell treatment 0.34 pcf MCQ
  - Vacuum -28 in Hg for 10 min
  - Pressure 140 psi for 10 min
- Expose to *Fra* in soil block test to get maximum % compression loss
- Cut section for compression test
  - 18 x 18 x 5 mm
- Cut 1 mm section for XRF and XRD analysis
  - 1 x 18 x 5 mm



MCQ Day 31



MCQ Day 154

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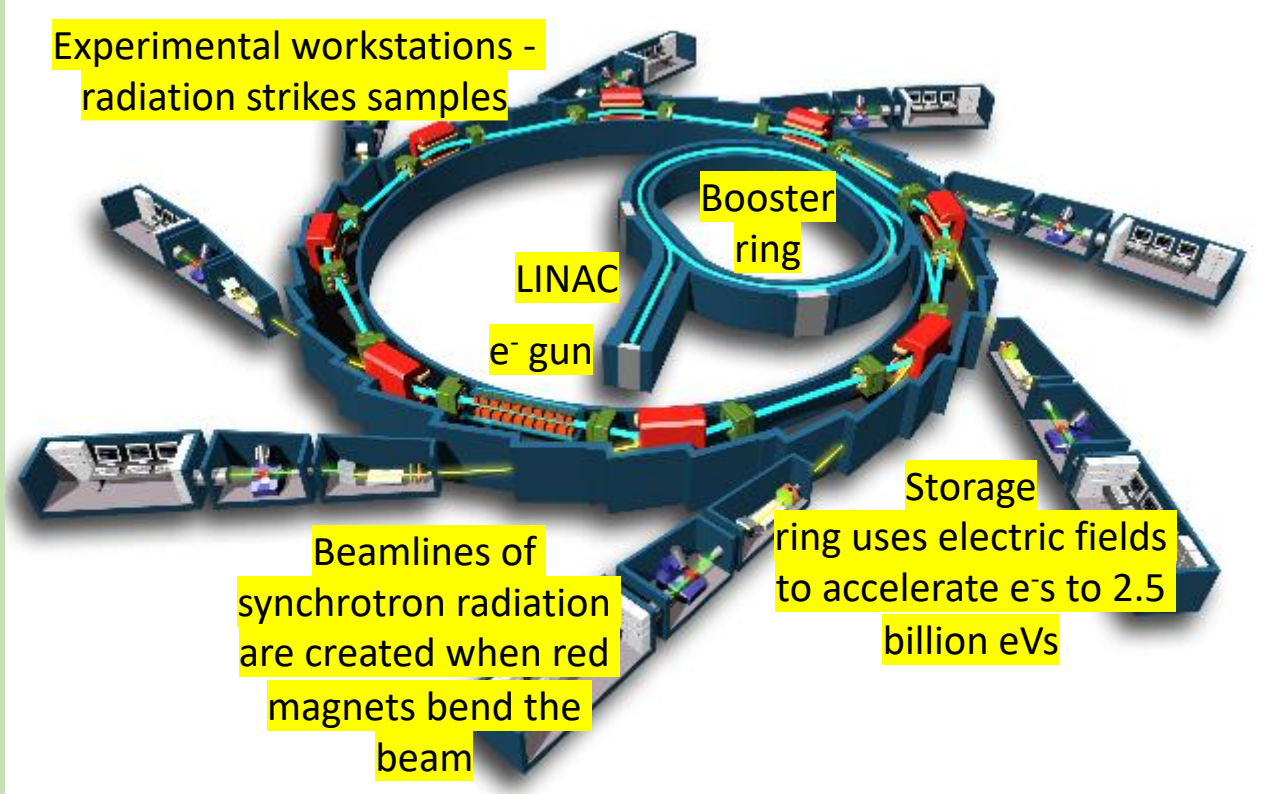
Synchrotron Radiation for XRD and XRF Analysis



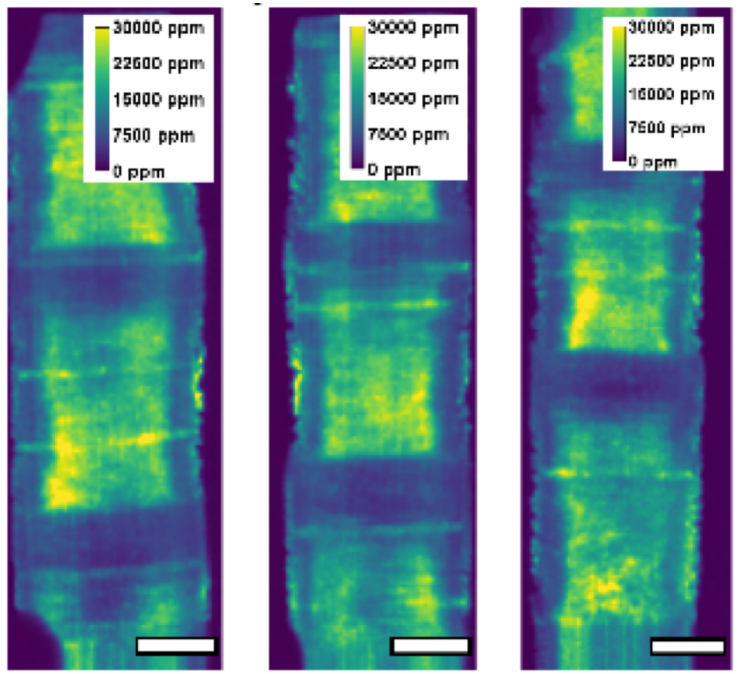
Synchrotron Soleil (copyright EPSIM 3D/JF Santarelli)

- DiffAbs Workstation

XRF Mapping of Cu

- Shoot beamline at pellets made with a known amount of $CuCO_3$ for ppm calibration curve
- Unexposed MCQ wood
  - More Cu in earlywood (> 22K ppm) than latewood (7500 ppm)
    - smaller pores of latewood pickup less preservative
  - Fairly uniform distribution in both earlywood and latewood
    - Some regions of high concentration and an occasional area of low concentration
  - X-sectional faces generally have lower Cu (7500 ppm)
    - wafers dabbed on paper towels to remove excess

Unexposed MCQ

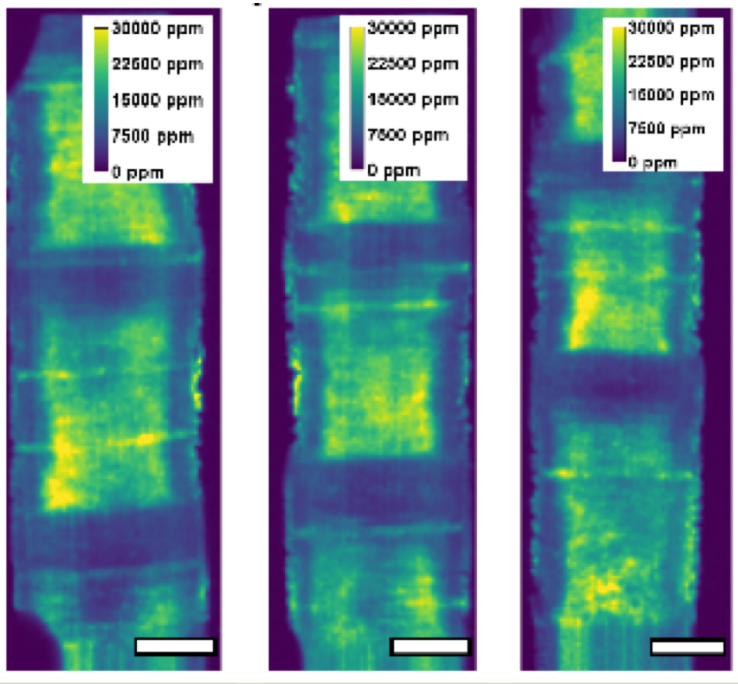


Unexposed untreated 0 ppm Cu

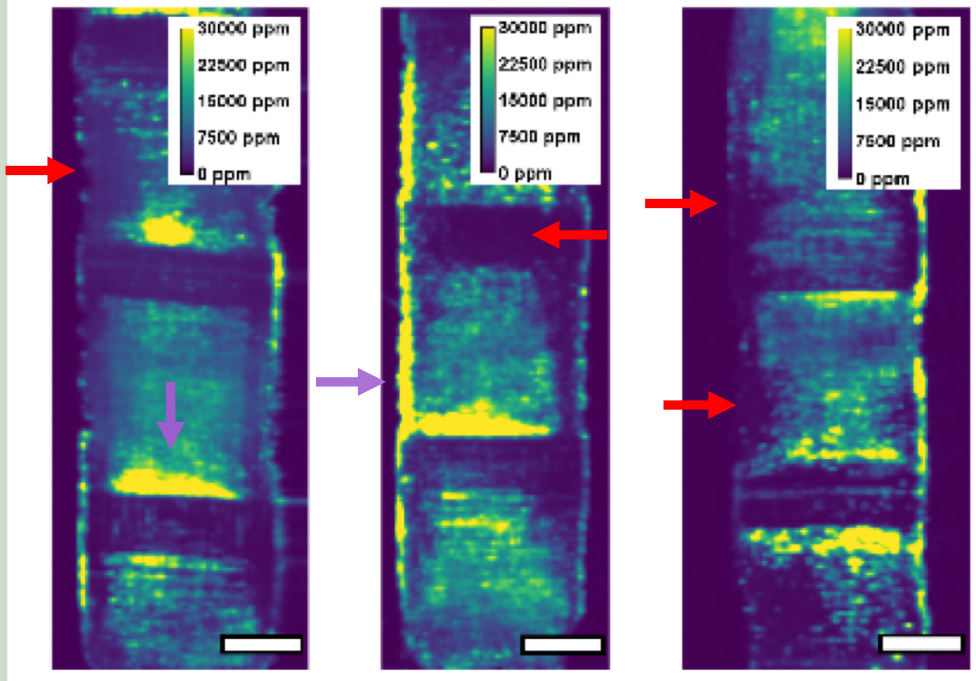
XRF Mapping of Cu in MCQ Wood

- Day 25
- 0% strength loss
- Cu distribution more patchy
- Uniform glow less apparent
- High Cu (→) 30K ppm
- Low Cu (→) <7500 ppm

Unexposed



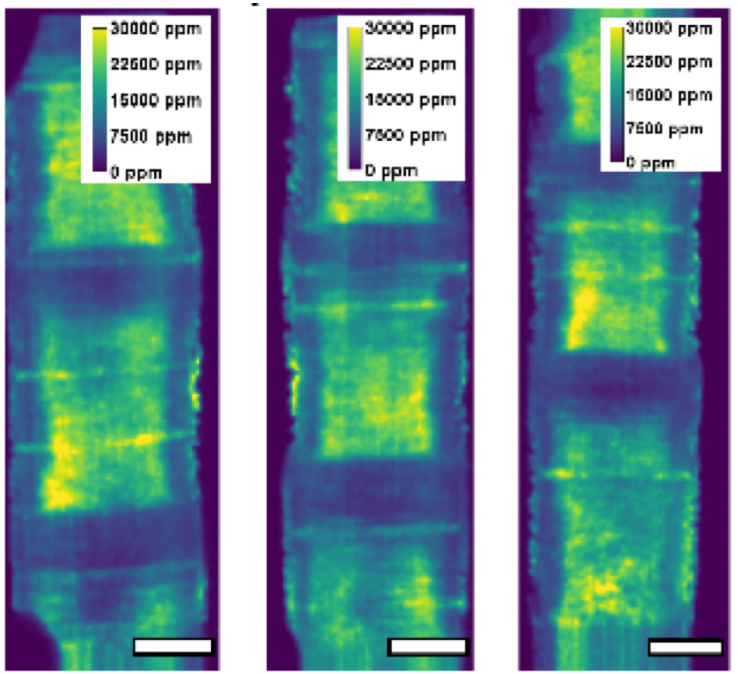
Exposed 25 Days



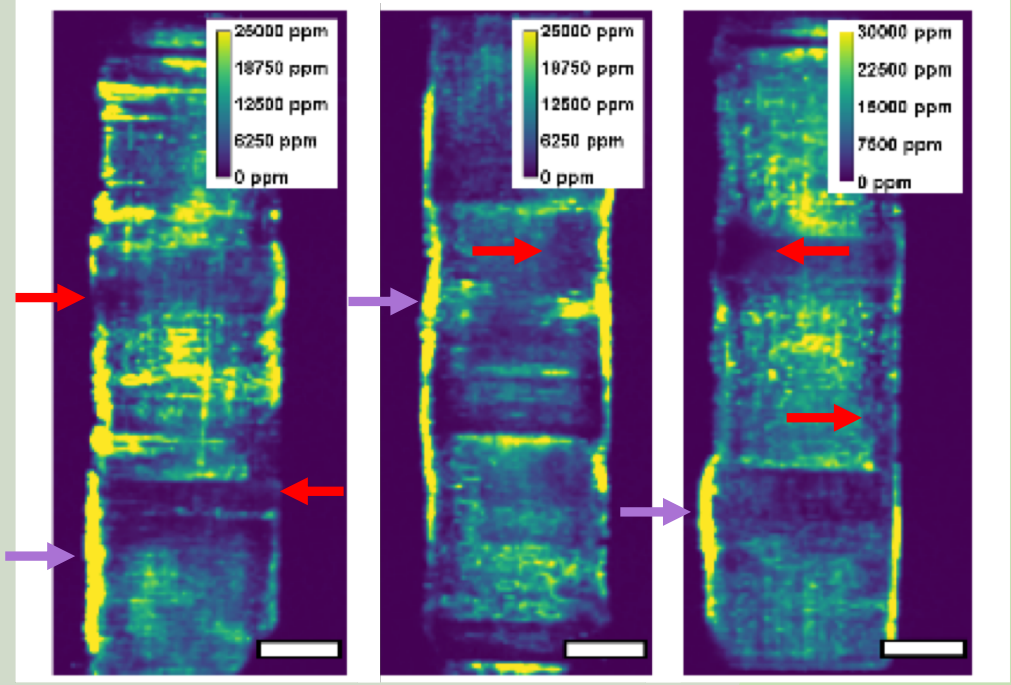
XRF Mapping of Cu in MCQ Wood

- Day 70
- < 5% strength loss
- Patchiness more obvious in both earlywood and latewood
- More areas with high Cu (→) (25K – 30K ppm)
- More areas with low Cu (→) (<7500 ppm)

Unexposed



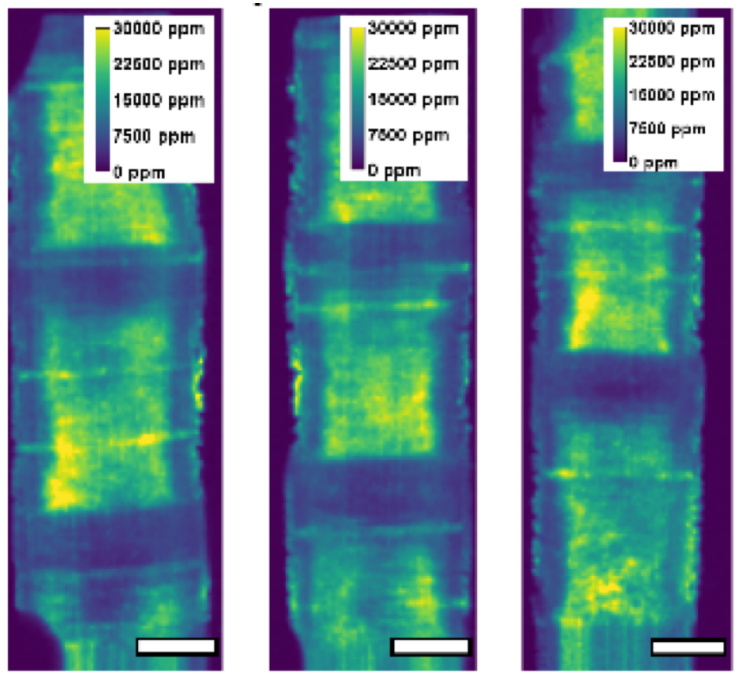
Exposed 70 Days



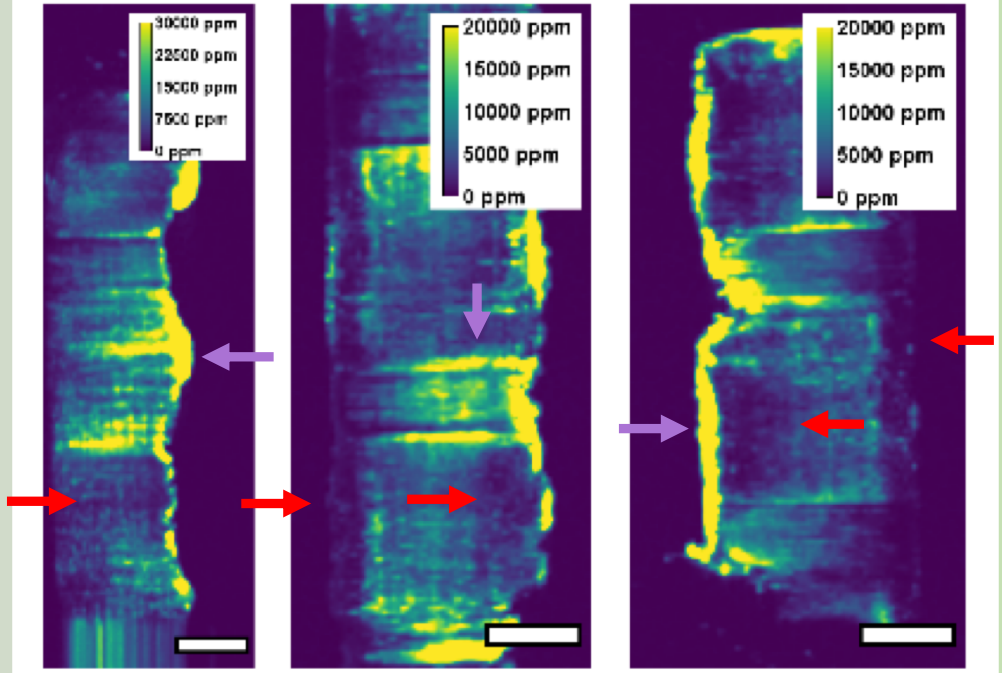
XRF Mapping of Cu in MCQ Wood

- Day 154
- > 50% strength loss
- Shrinkage along X-cut face in contact with fungus on feeder strip
- High Cu along shrunken edges and at boundary of earlywood and latewood (→)
- Low Cu elsewhere within wafer and on X-cut face that was not in contact with fungus (→)

Unexposed

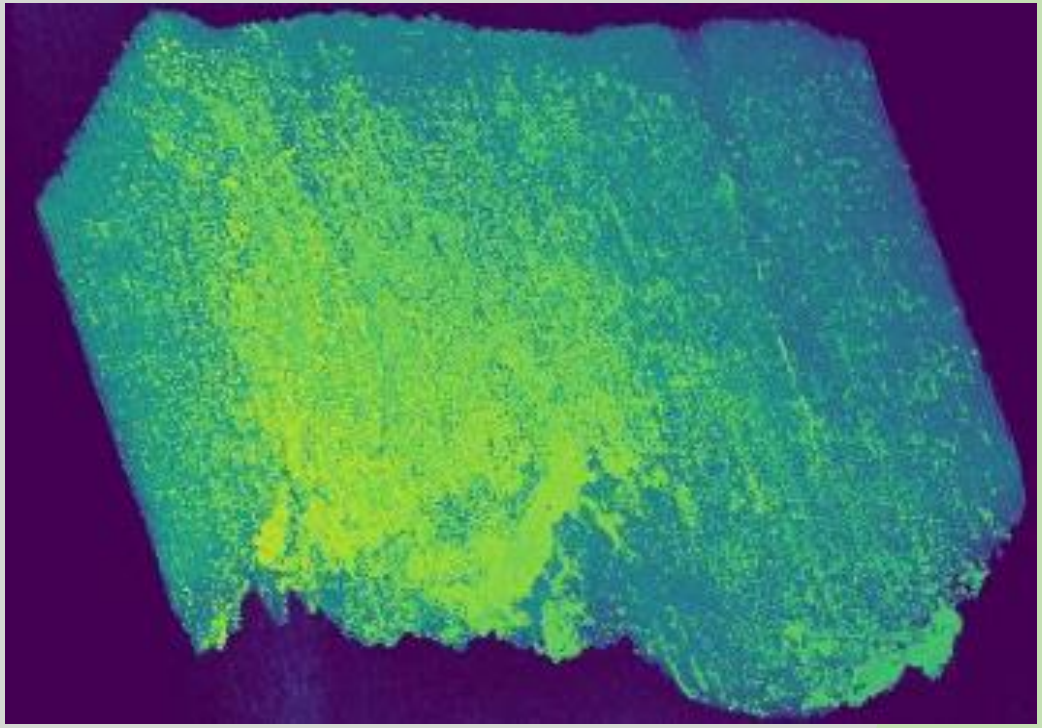


Exposed 154 Days



XRD 3D Crystal Map of MCQ Wood Day 154

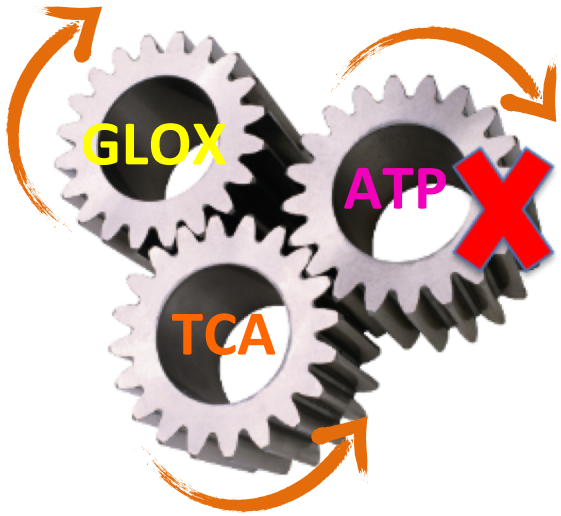
- Distribution and loading of copper oxalate crystal
  - CuOx crystal distribution is not uniform but extremely patchy
- Consistent with XRF Cu mapping results



Summary & Conclusions

- Fungus action on treated wood
  - Spatial - uniform to patchy Cu distribution
  - Temporal – starts before wood shows strength loss and appears to continue as wood is decayed
  - Chemical - transformation of Cu from carbonate to oxalate forms
- Implications
  - Activities require high amounts of energy or ATP

Adds support to hypothesis that disabling ATP production will defeat Cu tolerance



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