# Worlds Largest Industrial Application of NanoParticles

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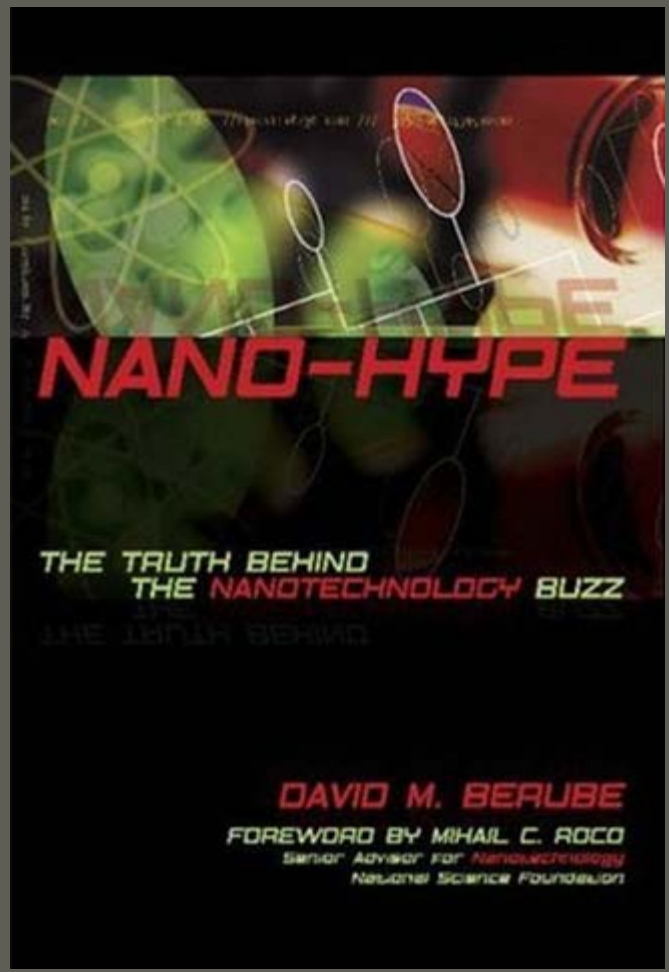
# Nano-Hype

- There's still a large gap between scientific interest in nanotechnology and its commercial impacts



# Nanoparticles for Wood Protection

- The large scale use of nanoparticles for wood preservation has largely gone unnoticed by the nanotech community



## Large-scale application of nanotechnology for wood protection

**To the Editor:** A number of recent articles in this journal have commented on the gap between the scientific interest in nanotechnology and its commercial impacts[1,2]. Some commentators have even suggested that failure of nanotechnology to deliver substantial returns on investment will undermine the generous support that the field receives[2,3]. It is surprising, therefore, that the large-scale commercial use of nanoparticles for the biological protection of timber seems to have escaped the attention of many working in the nanotechnology field.

In the past two years, a number of North American chemical companies have commercialized wood preservatives that consist of copper carbonate particles and an organic co-biocide, both dispersed in water[4]. The copper particles, which vary in size from 1 nm to 25 μm, are made by ball-milling an aqueous slurry of copper carbonate and wetting agents[4]. Nanoparticles, some as small as 20 nm in diameter, are abundant in the aqueous preservative, whereas larger particles are more prominent in treated wood where they accumulate on cell walls and within the openings that connect the cellular elements of the wood (Fig. 1).

The market for treated wood in North America is valued at $4.9 billion (gross sales), and each year around 20 million cubic metres of wood are treated with aqueous, mainly copper-based, preservatives[5]. The annual consumption of copper salts for wood protection in North America, which represents 50% of the global market for wood preservatives, is estimated to be 79,000 tonnes[5]. The new nano-copper preservatives compete with treatments that contain dissolved or complexed copper salts, and this year they have captured at least 50% of the North American market, making the seemingly mundane application of wood protection one of the world's largest end uses of nanoparticles.

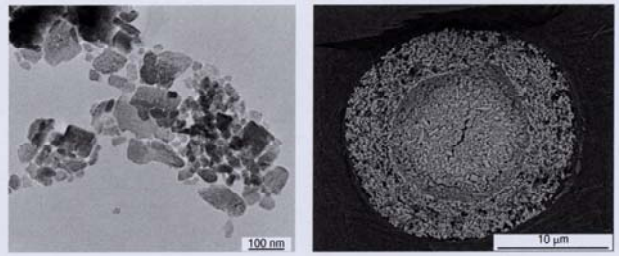



**Figure 1** Copper carbonate micro- and nanoparticles in a commercially produced wood preservative (left) and accumulation of larger particles on a membrane within an opening (bordered pit) that connects fibres in treated southern pine wood (right).

Unusually, this large-scale commercial use of nanotechnology for wood protection was not preceded by much interest in the area from the scientific community, despite widespread recognition that nanotechnology has great potential to improve the performance of wood and other cellulosic materials[6]. Some publications are now appearing in the open literature on the new preservative systems[7–9], but the number of scientists working in the field of wood protection is small and they have little experience with nanotechnology. Hence, progress in understanding the properties and mode of action of the new nano-preservative systems has been slow.

We seek through this letter to encourage broader engagement in this field by the nanotechnology community to close the gap more rapidly between the commercial exploitation of the new treatments and the underlying science. This could lead to improvements to the current systems and, perhaps, the development of radically new treatments, which could result in further large-scale use of nanotechnology in the commercially significant building and construction sector.

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# Wood Preservative Treatment

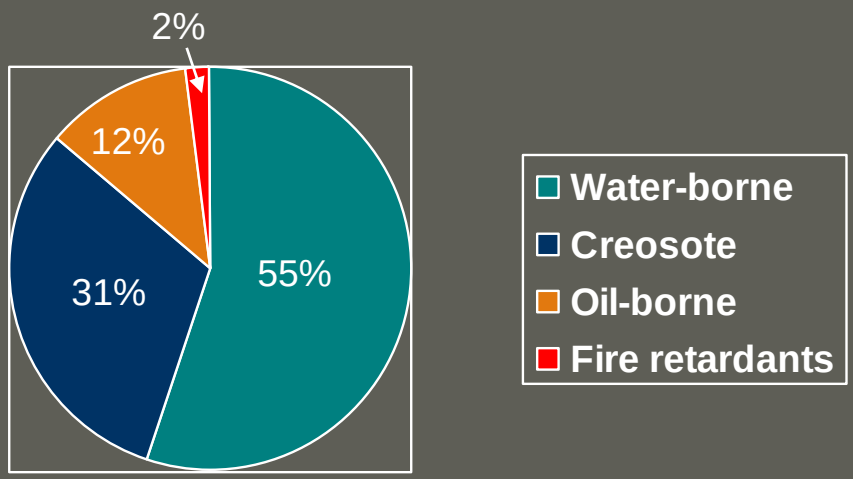
- Treated wood products include
  - Lumber, decking, posts, poles, stakes, pickets, landscape timbers


# Requirements of Wood Preservatives

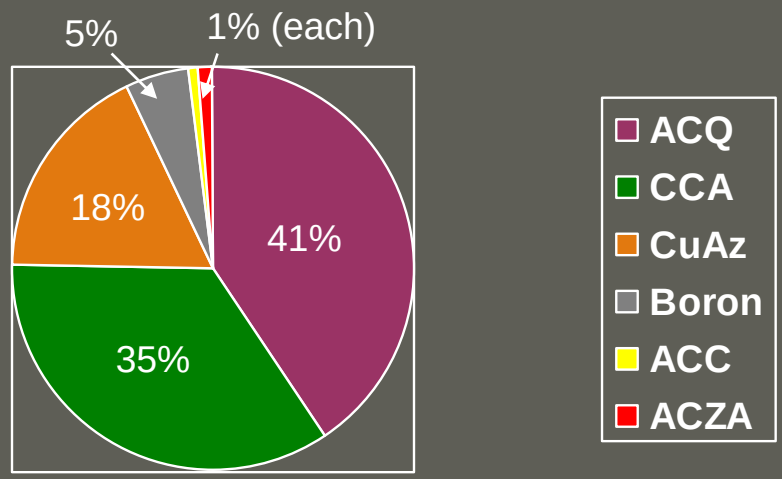
- Toxicity towards wood destroying organisms
- Permanence in treated wood, ie, non leachable
- Ability to penetrate deeply into the wood
- Freedom from any unwanted effects on the wood
- Non corrosive to metals
- Without harmful effects on the environment (people, animals and plants)
- Low cost!

# Wood Preservatives In North America

- Market for treated wood in North America is valued at $4.9 billion (gross sales per year)
- Each year 20 million cubic metres of wood products are treated
- Annual consumption of copper salts ~ 79 000 tons




Market share for different preservatives (2004)




Market share for different water borne preservatives (2004)

# Nano-Wood Preservative

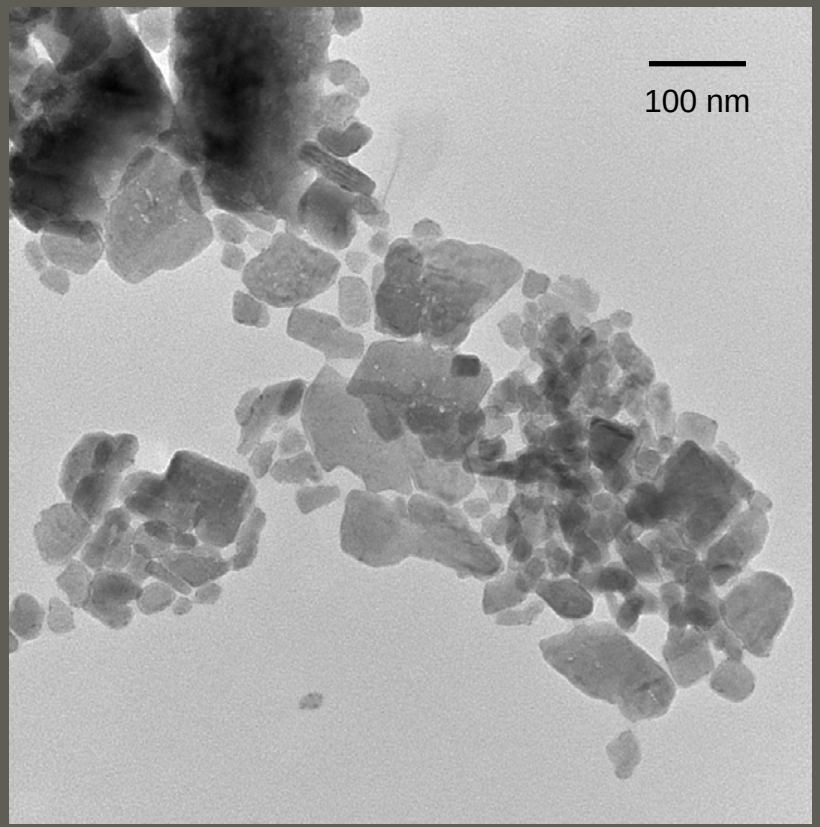
- A new copper preservative consisting of copper carbonate or oxide micro and nano particles was launched commercially in 2006
- The preservative has now captured ~ 75 to 90% of the market for copper-based wood preservatives because it shows less leaching of copper, reduced corrosion of metal fixings, and lower levels of copper are needed to treat wood (less costly)

Micronised preservative concentrate containing 41% Cu particles


Micronised copper treated decking

# Registration & Performance of Nano Copper Preservatives

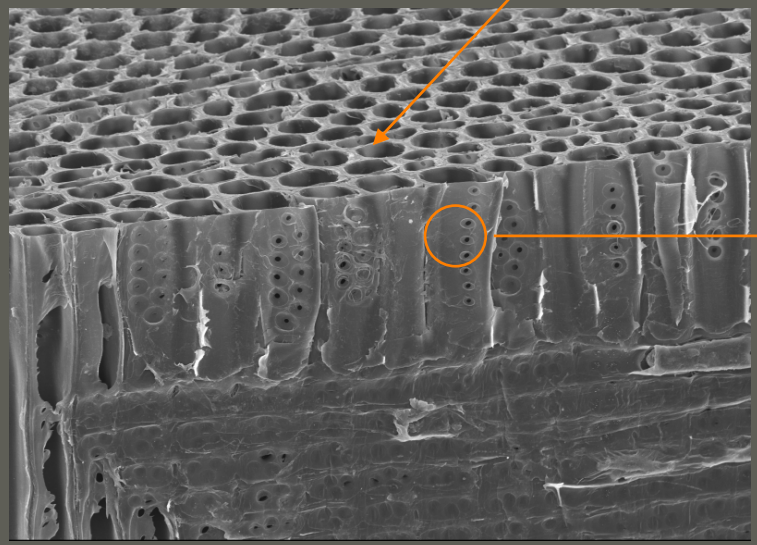
- The new particulate copper preservatives were approved for use because they contained biocides that were already used in wood preservatives (and the preservative was considered a micronised rather than a nano material)
- But does the presence of copper in particulate rather than ionic form influence preservative performance?

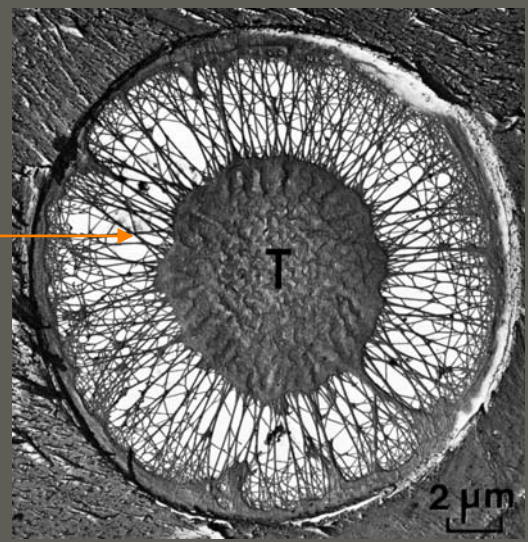



Copper carbonate particles in a commercial wood preservative

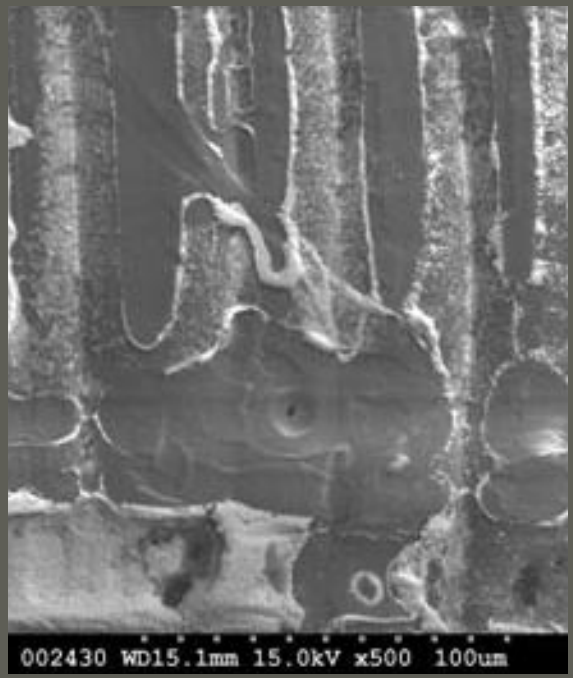
# Preservative Distribution

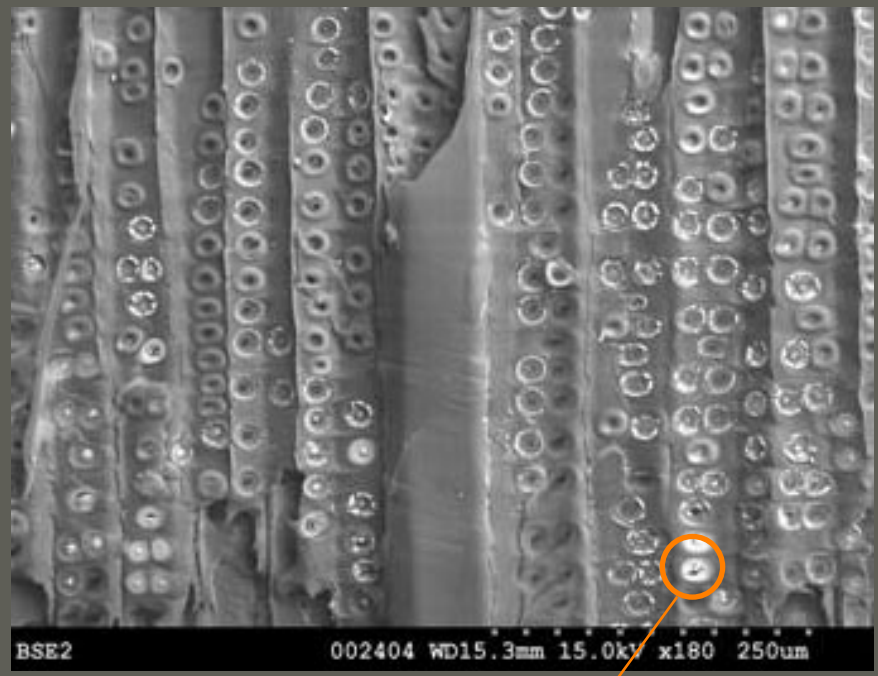
To be effective wood preservatives need to penetrate wood's microstructure and diffuse into cell walls

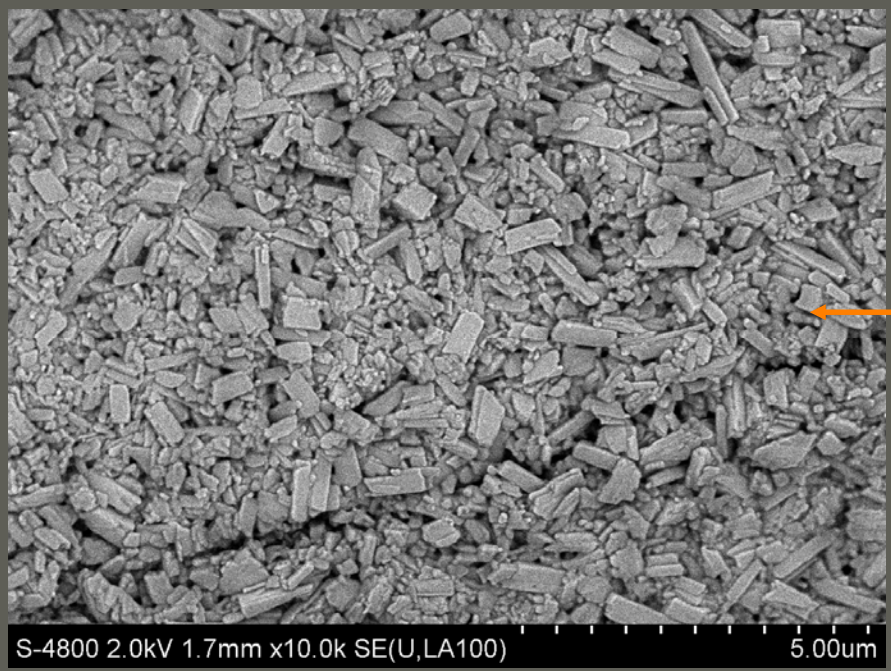



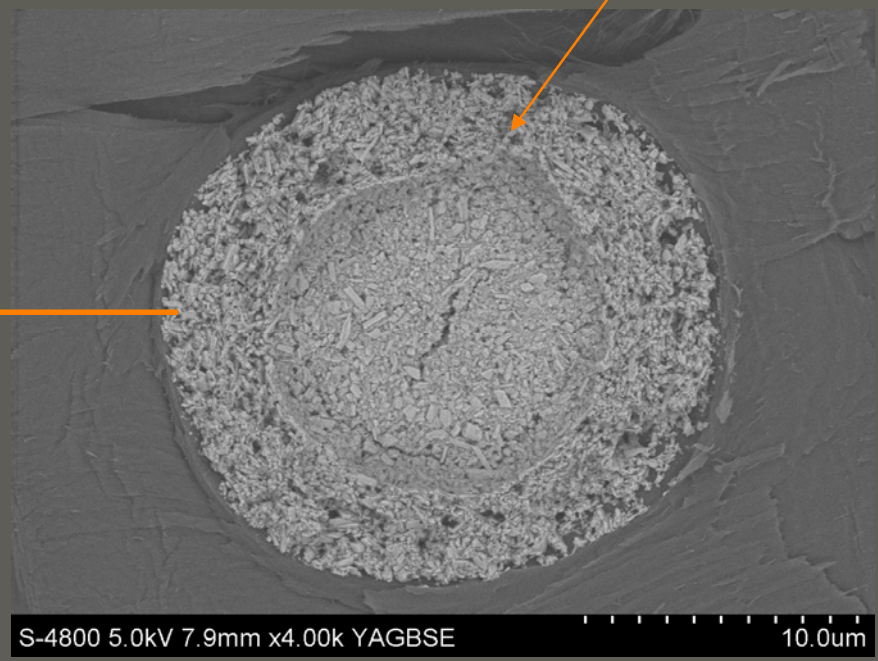


# Copper Carbonate Particles in Treated Wood

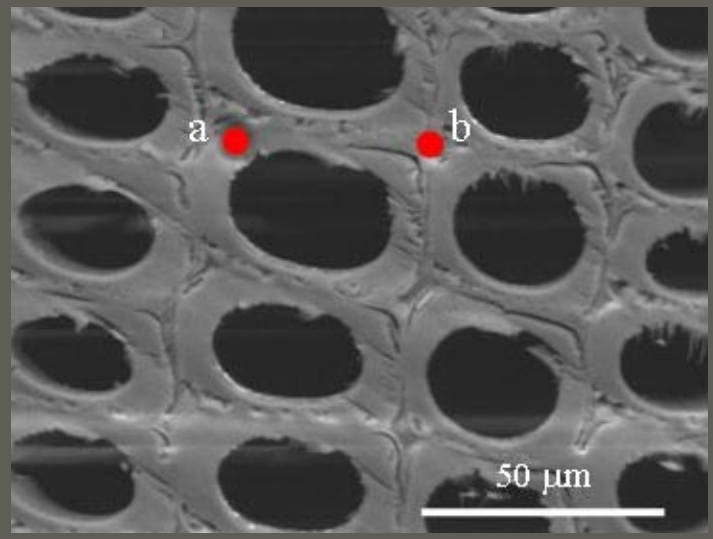


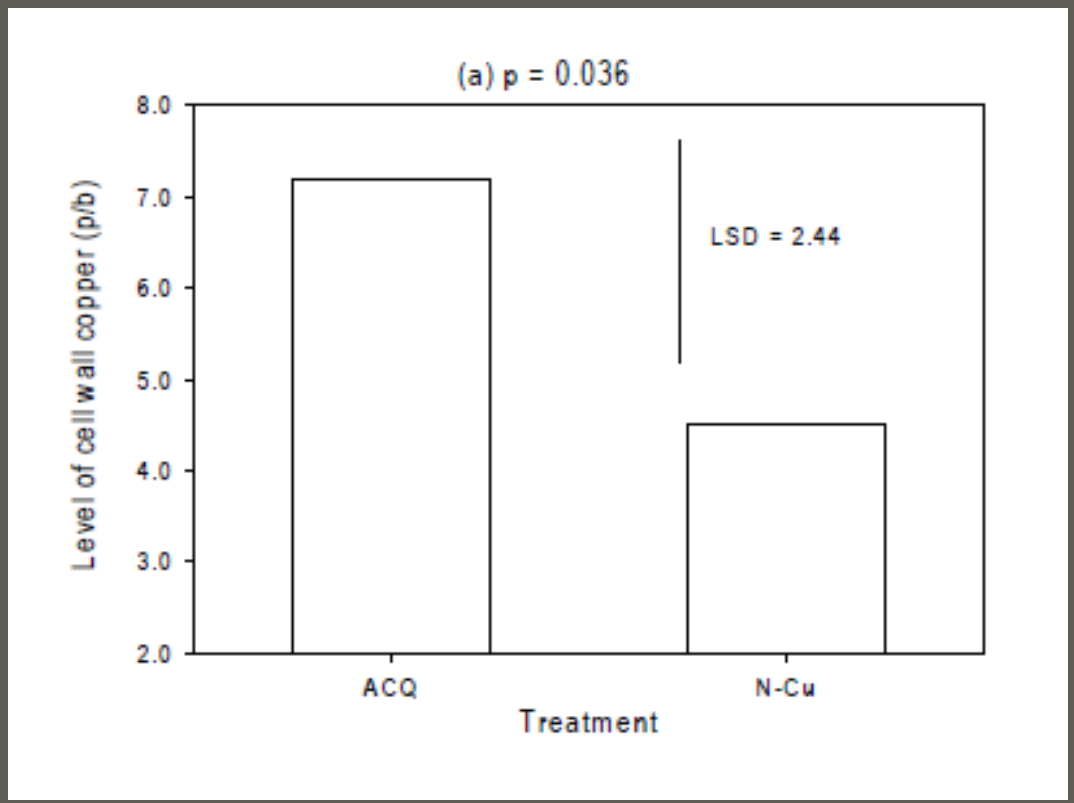



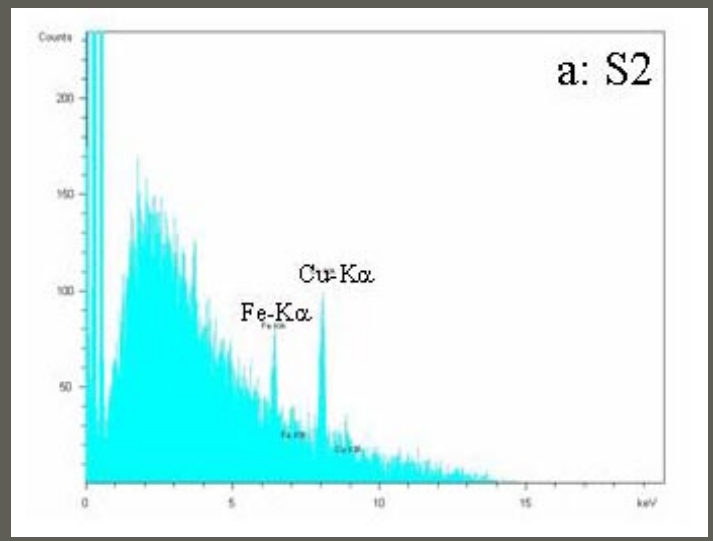



# Copper is present in cell walls of wood treated with the new preservative

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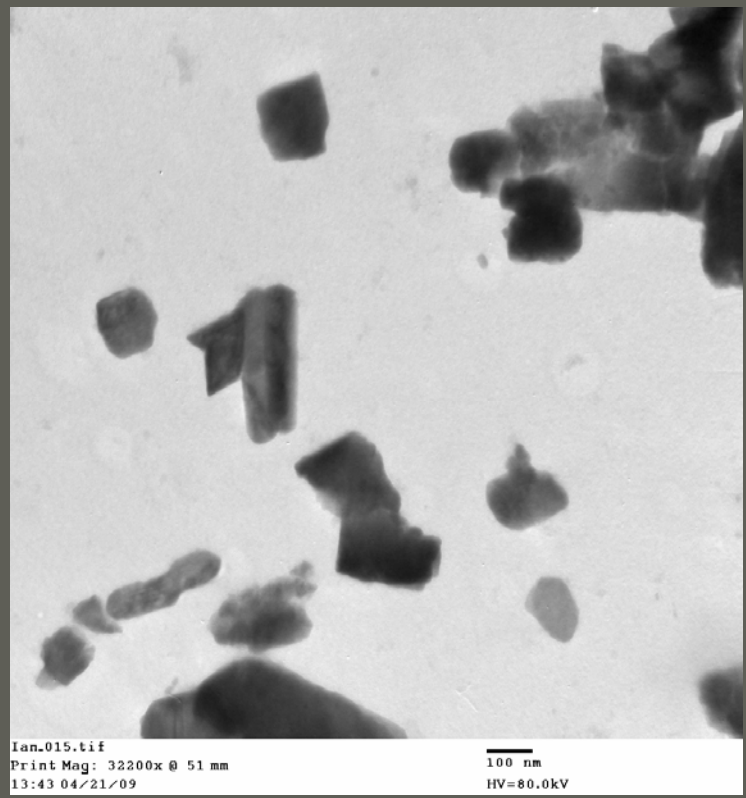
# Outstanding Issues

- Do copper carbonate nanoparticles penetrate wood cell walls?
- Can the short term tests on wood treated with the new wood preservative predict its long term performance
- What are the potential environmental impacts of the treated wood


Condition of treated wood stakes after field testing

# Conclusions

- The commercialisation of nano-particulate wood preservatives illustrates how rapidly nano-technology can adopted by the forest products and building sectors (and how commercial developments can rapidly outstrip our understanding of the properties of the new materials)
- There's great scope for improvement to the current systems




Copper carbonate nanoparticles leached from a treated deck

# Thank you for Your Attention

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# Any Questions?