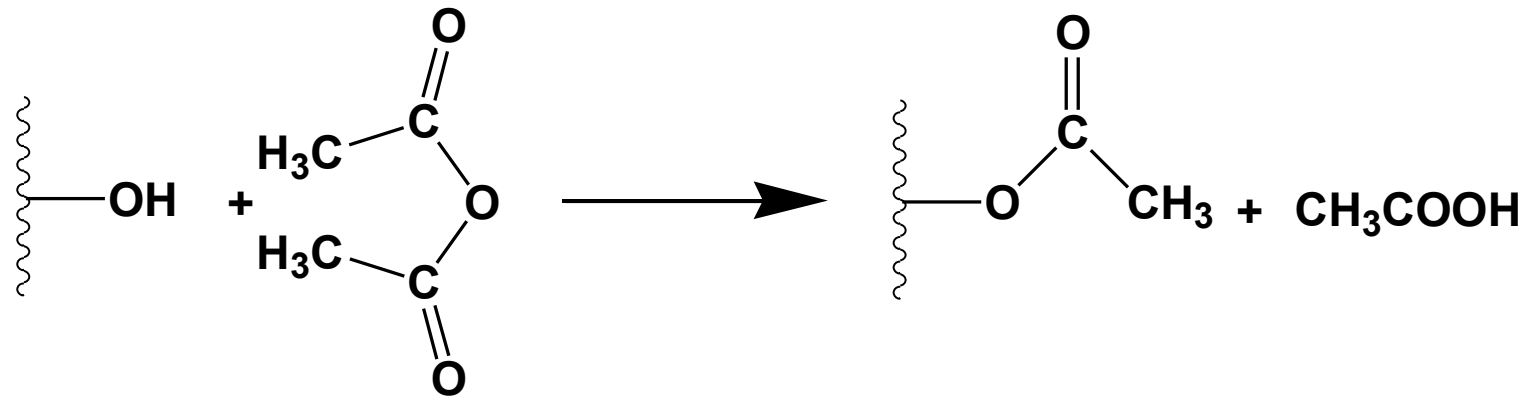


Establishing timber as a preferred material for construction

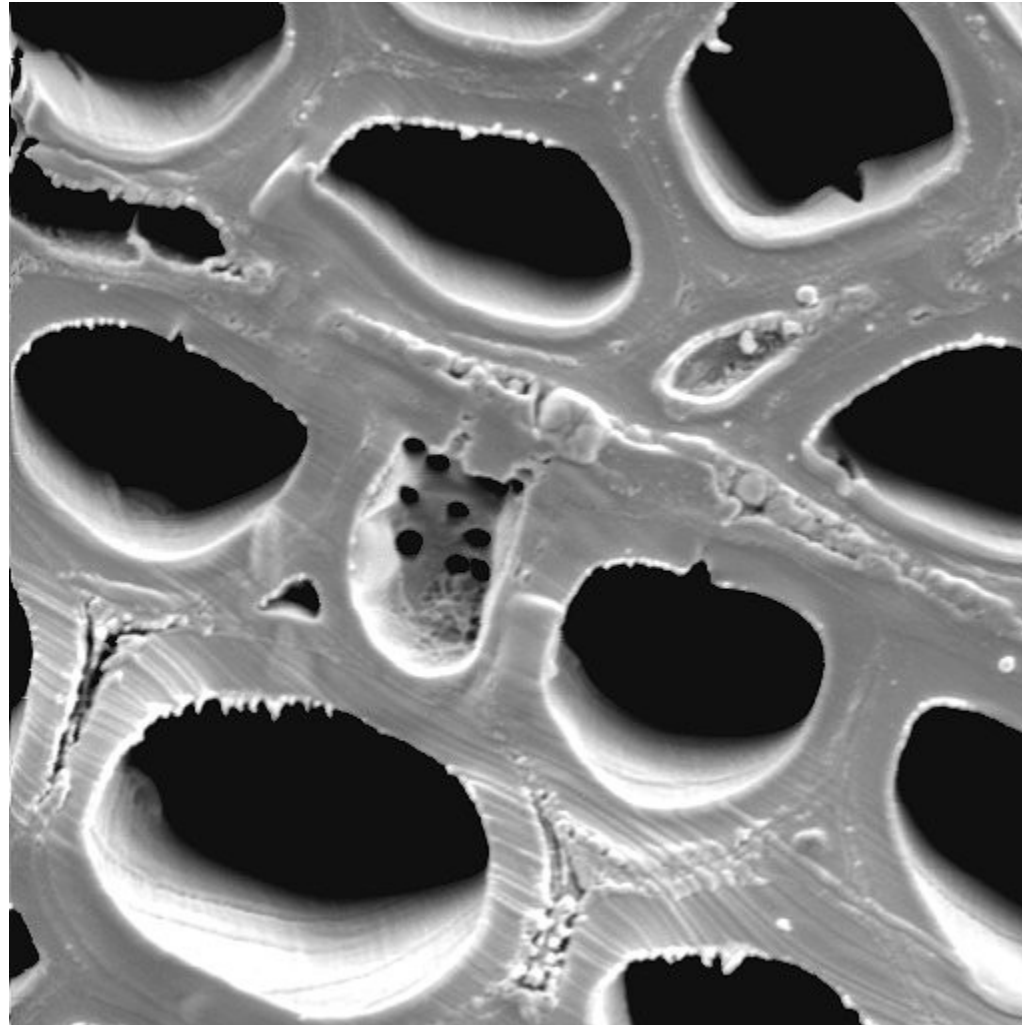
COST FP0802 VIENNA MAY 2009

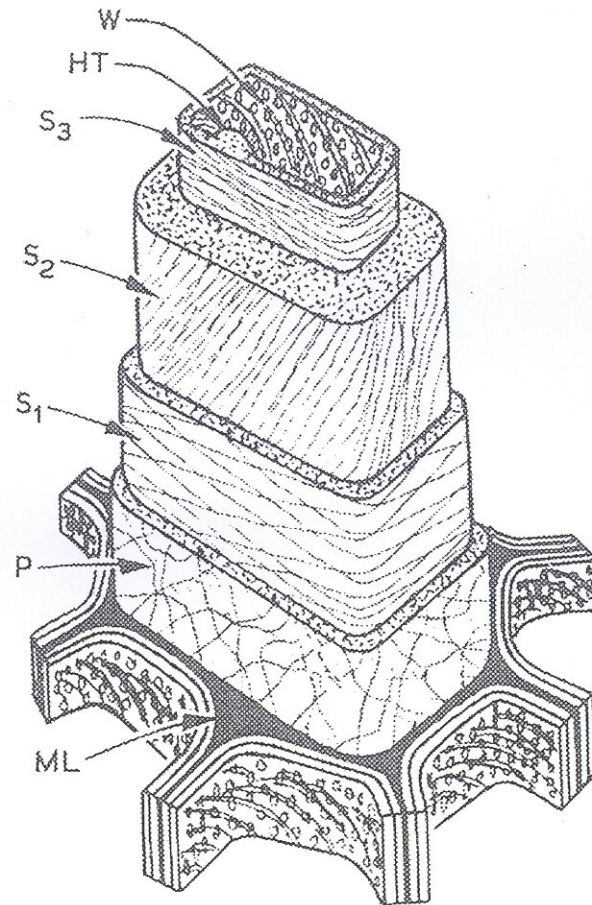
The Interaction Anhydride Modified Wood with Water

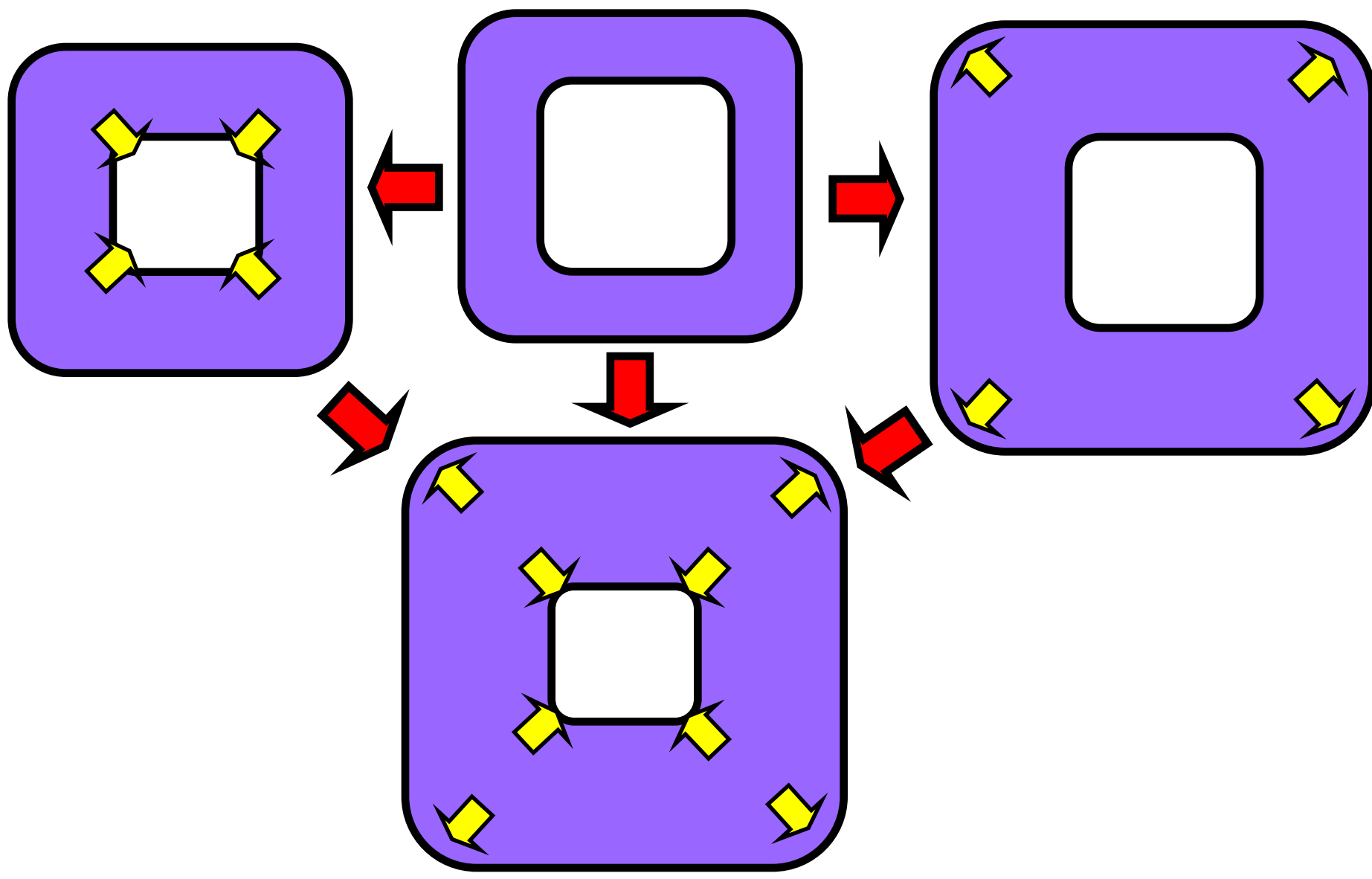
Prof. Callum Hill
Centre for Timber Engineering
Napier University

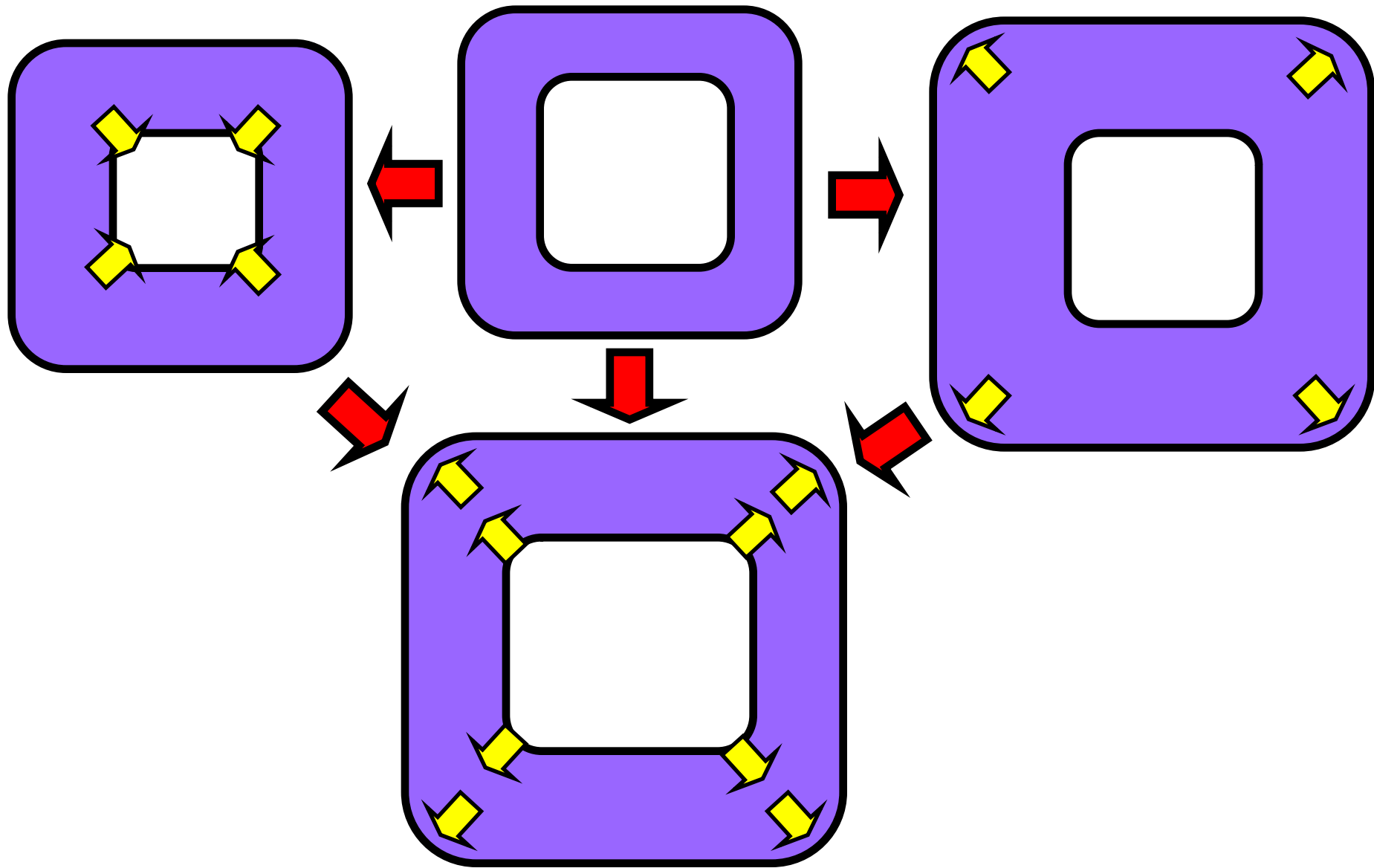


- As WPG increases the cell wall swells
- This is manifested as macroscopic swelling of the cell wall
- But the relationship between the two is not simple



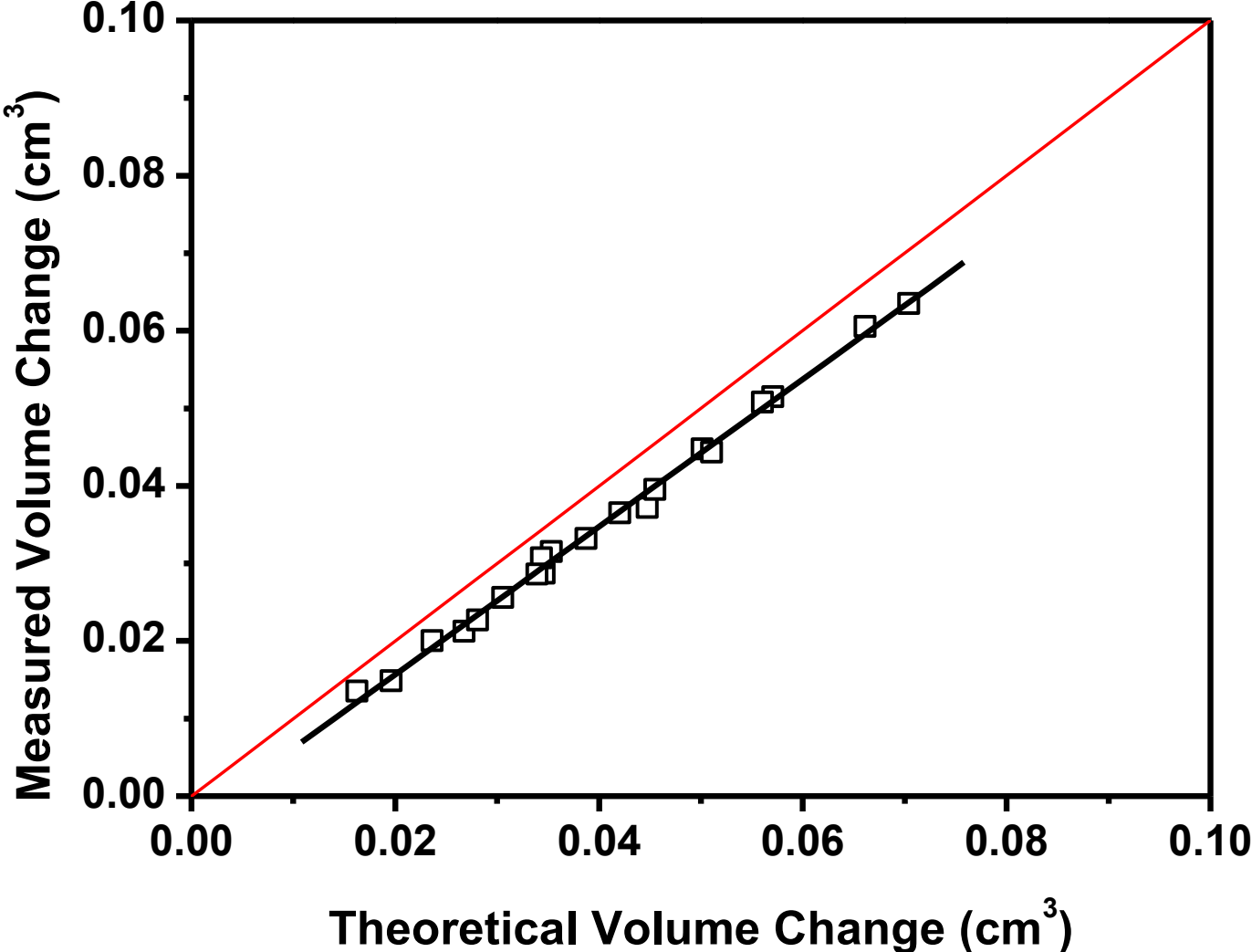


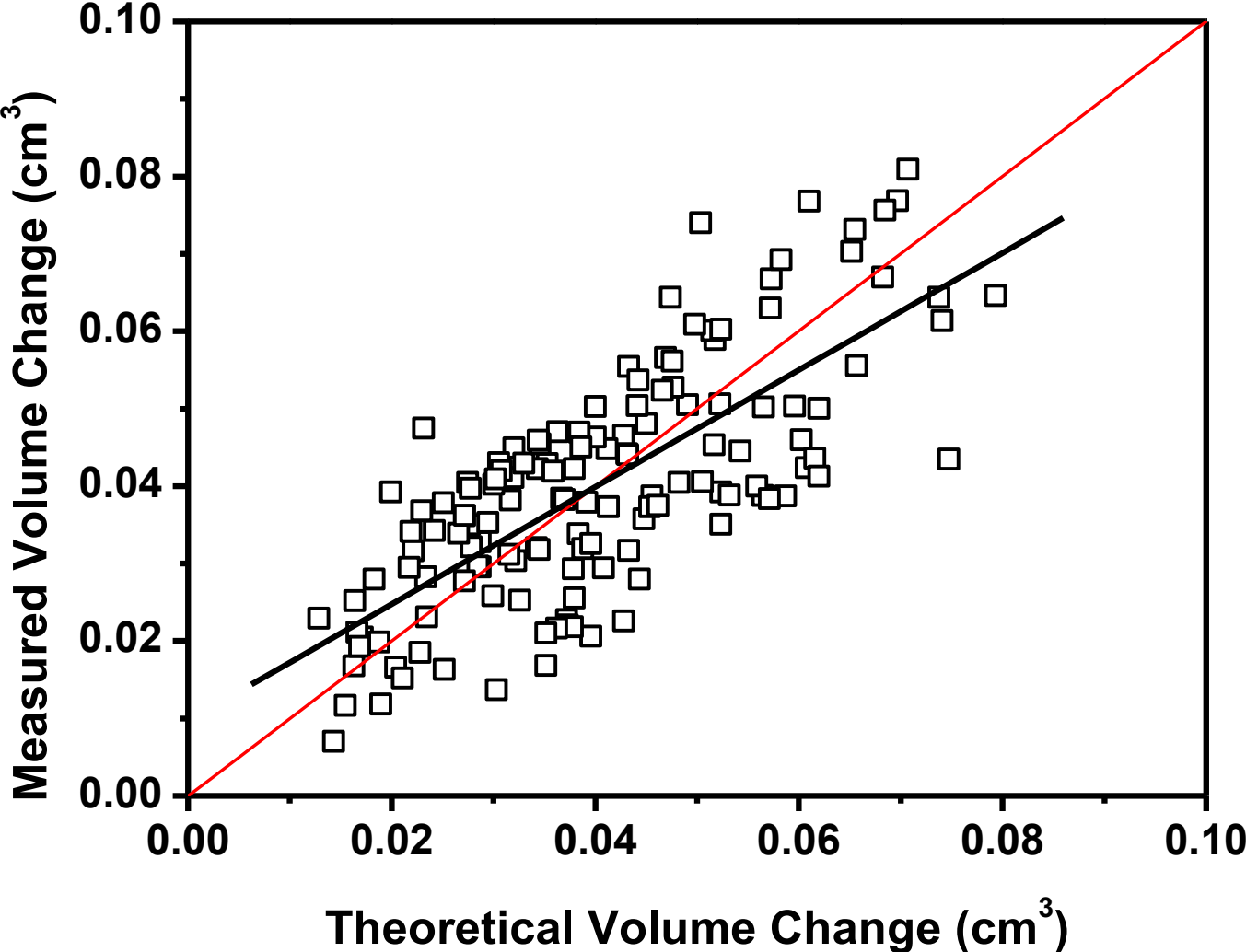




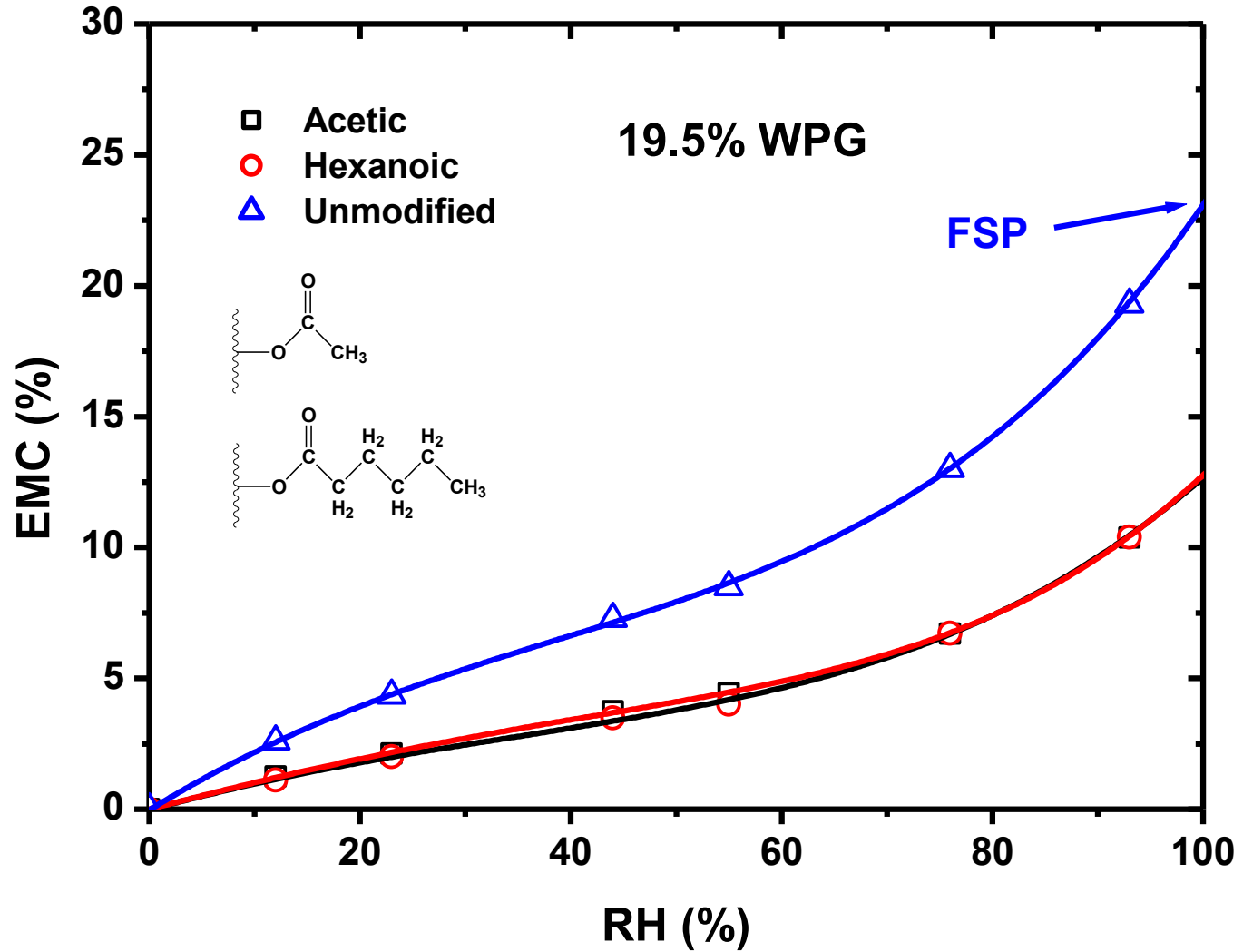
- Use helium pycnometry
- Must use dry samples
- Can use to determine volume swelling due to chemical modification
- Cannot use to determine cell wall volume swelling due to presence of moisture

- Roger Rowell used a value for density of acetyl group in the cell wall of 1.049 g cm^{-3} , which is the density of acetic acid
- **Question 1: is this a good idea or not?**
- Theoretical volume change can be calculated as: $(W_{\text{mod}} - W_{\text{unmod}})/1.049 \text{ cm}^3$

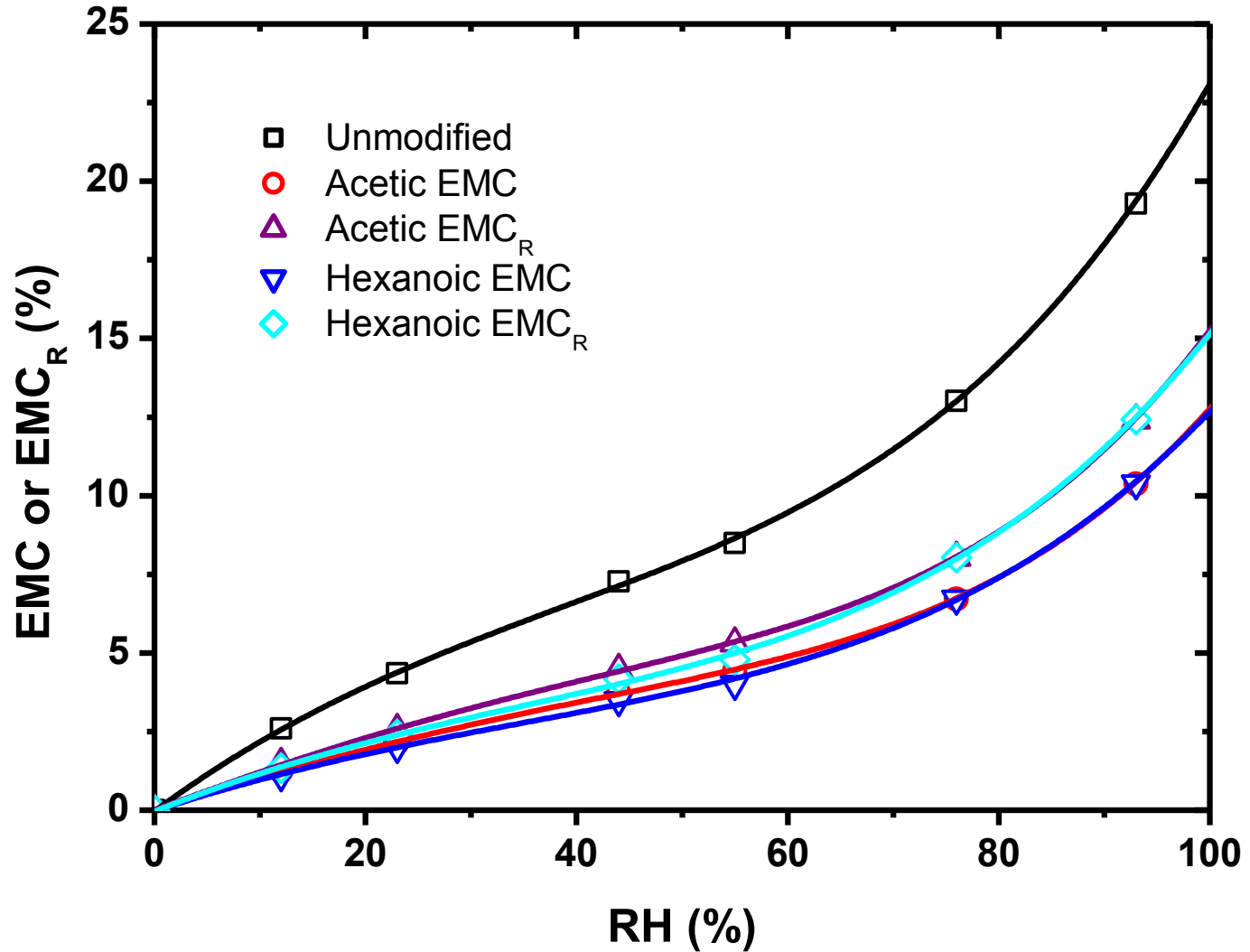




- What is the reason for reduction in cell wall moisture content due to modification with acetic anhydride?
- Is it because of loss of hydrophilic sorption sites (OH groups)?
- Is it because of cell wall bulking?



- EMC reduction is not due to OH substitution
- But – a word of warning
- EMC is reduced, in part, because the wood weighs more
- Therefore need to determine EMC_R
- Which is the moisture content based upon the cell wall mass (not cell wall mass plus adduct)

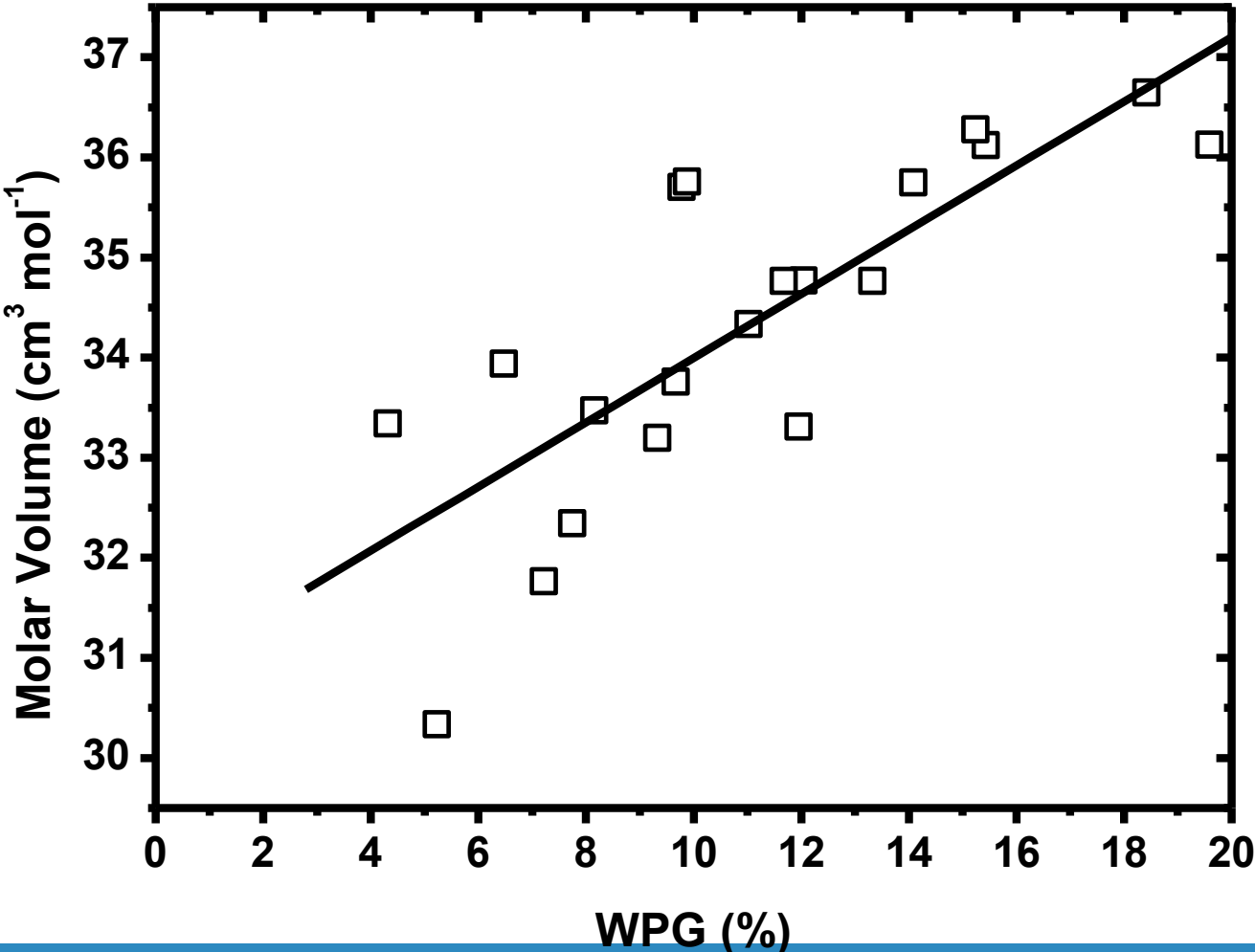


- If OH substitution is not the reason for a reduction in EMC is it cell wall bulking?
- We need to know how much volume the acetyl group occupies in the cell wall and we cannot get this by measuring external dimensional changes
- We have to use helium pycnometry

- This is the volume occupied by one mole of adduct
- Equivalent to the volume occupied by one acetyl group (divide molar volume by Avagadro's number)
- Should not change with WPG

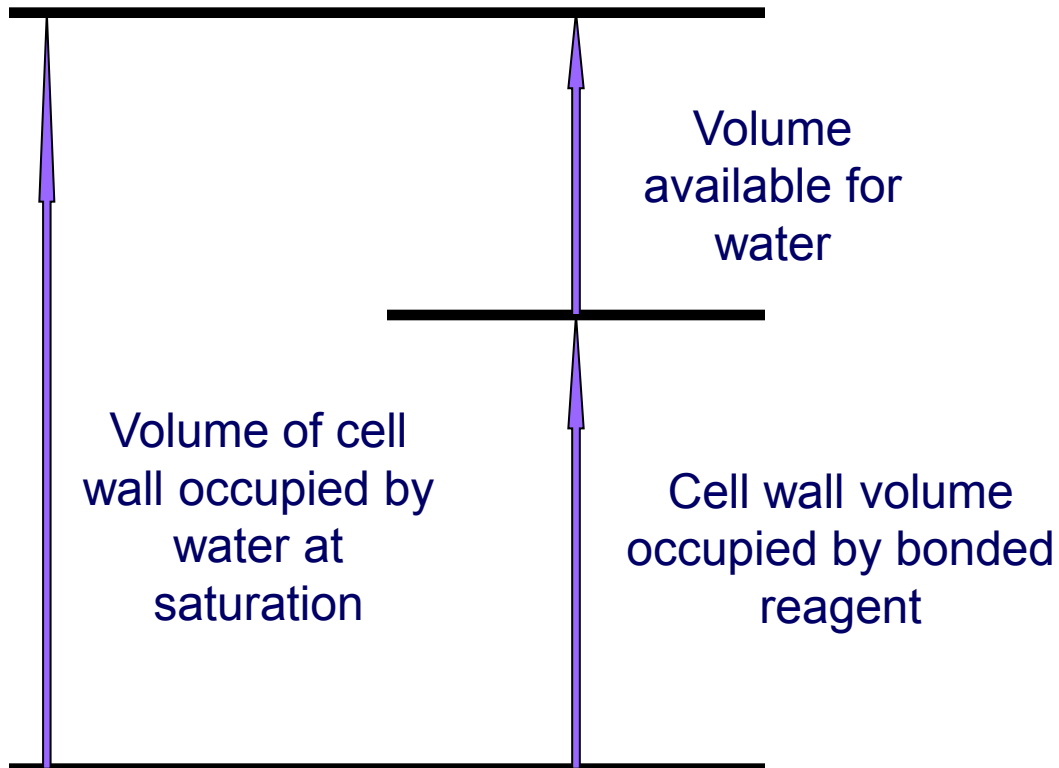
Molar volume =

$$\frac{[(V_{\text{mod}} - V_{\text{unmod}}) * MW]}{(W_{\text{mod}} - W_{\text{unmod}})}$$

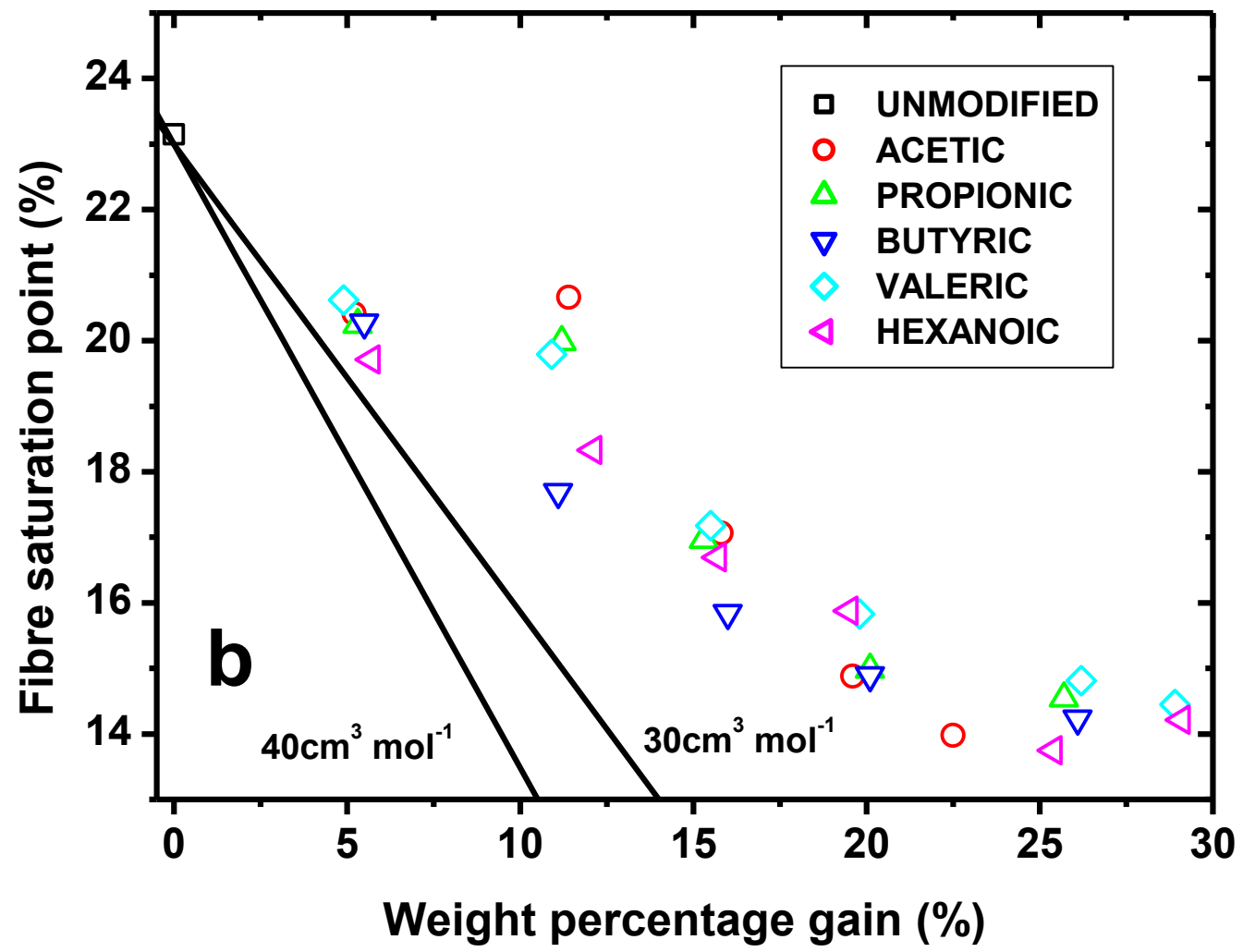


- Molar volume appears to vary with WPG (theoretically it should be constant)
- Molar volume has a value between 30 and 40 cm³ mol⁻¹

WATER-SATURATED CELL WALL VOLUME

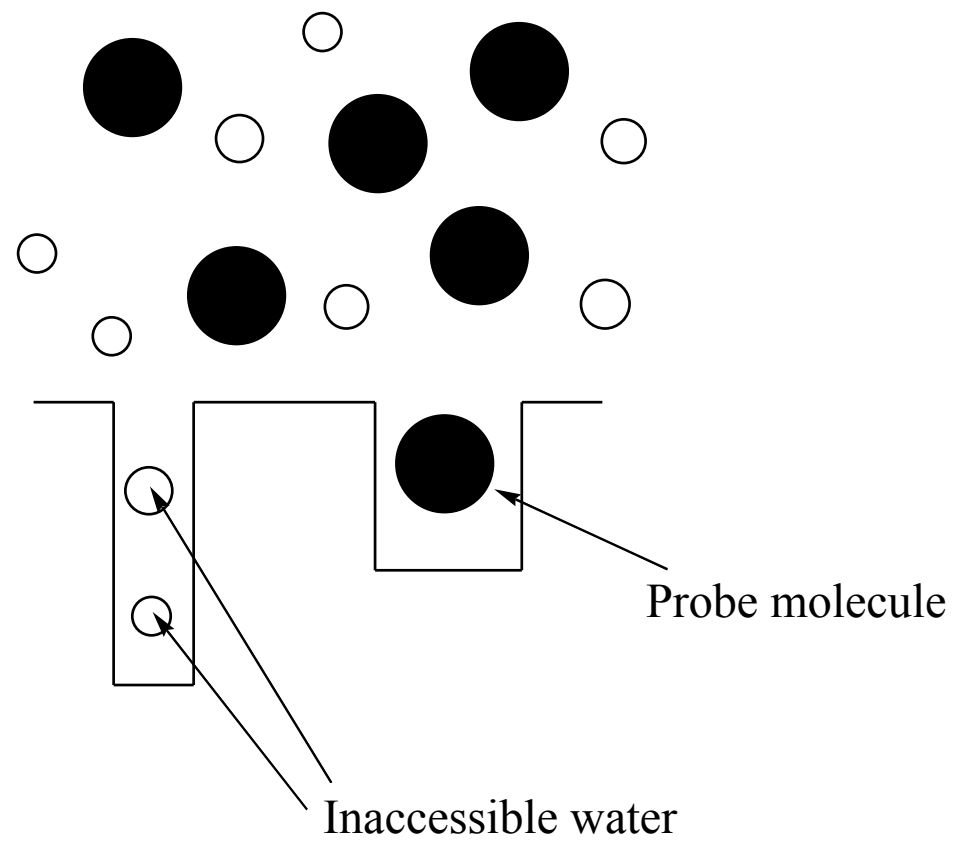


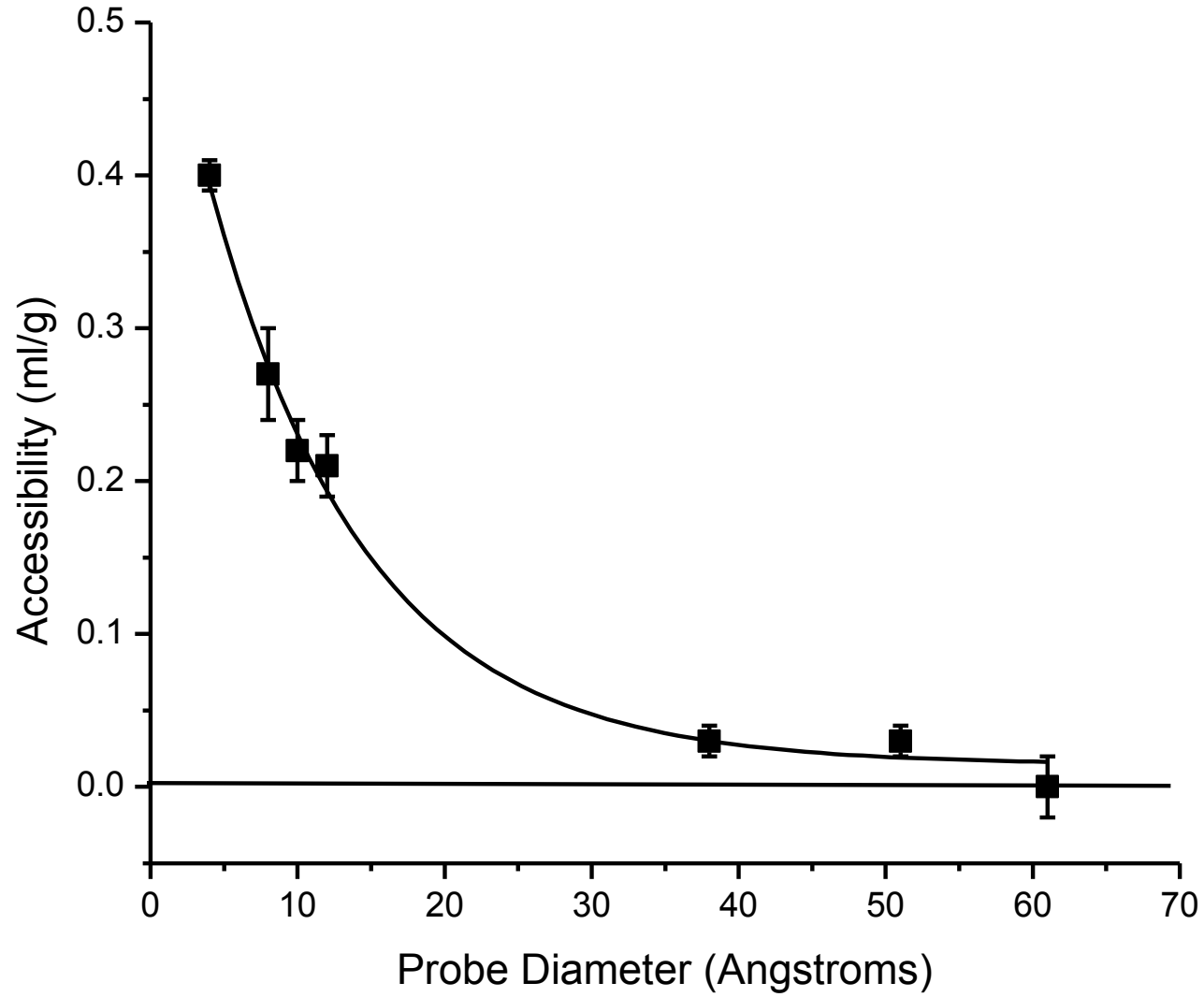
NB
THESE VOLUMES
CANNOT BE
DETERMINED BY
MEASURING THE
EXTERNAL
DIMENSIONS OF
THE SAMPLE

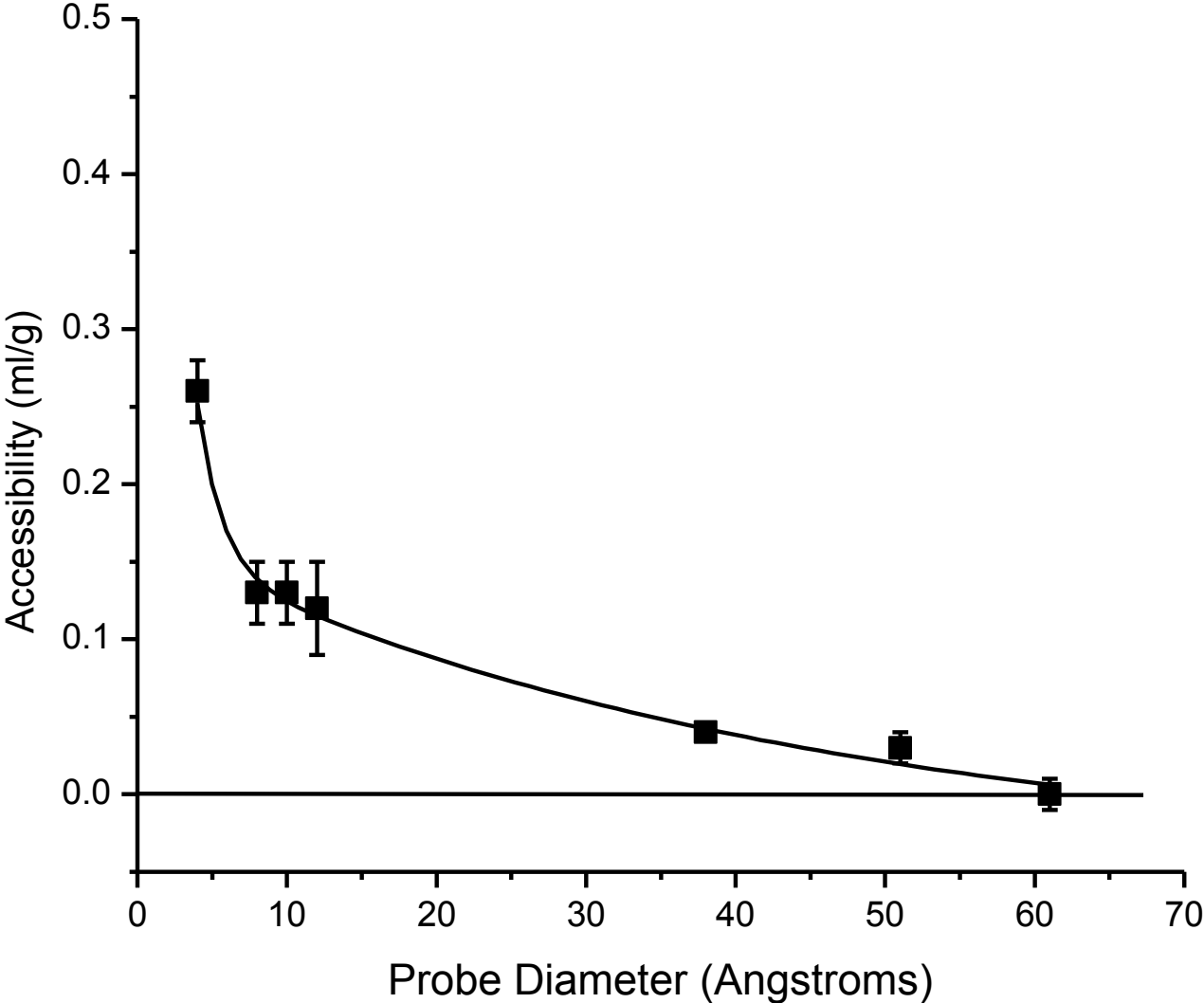


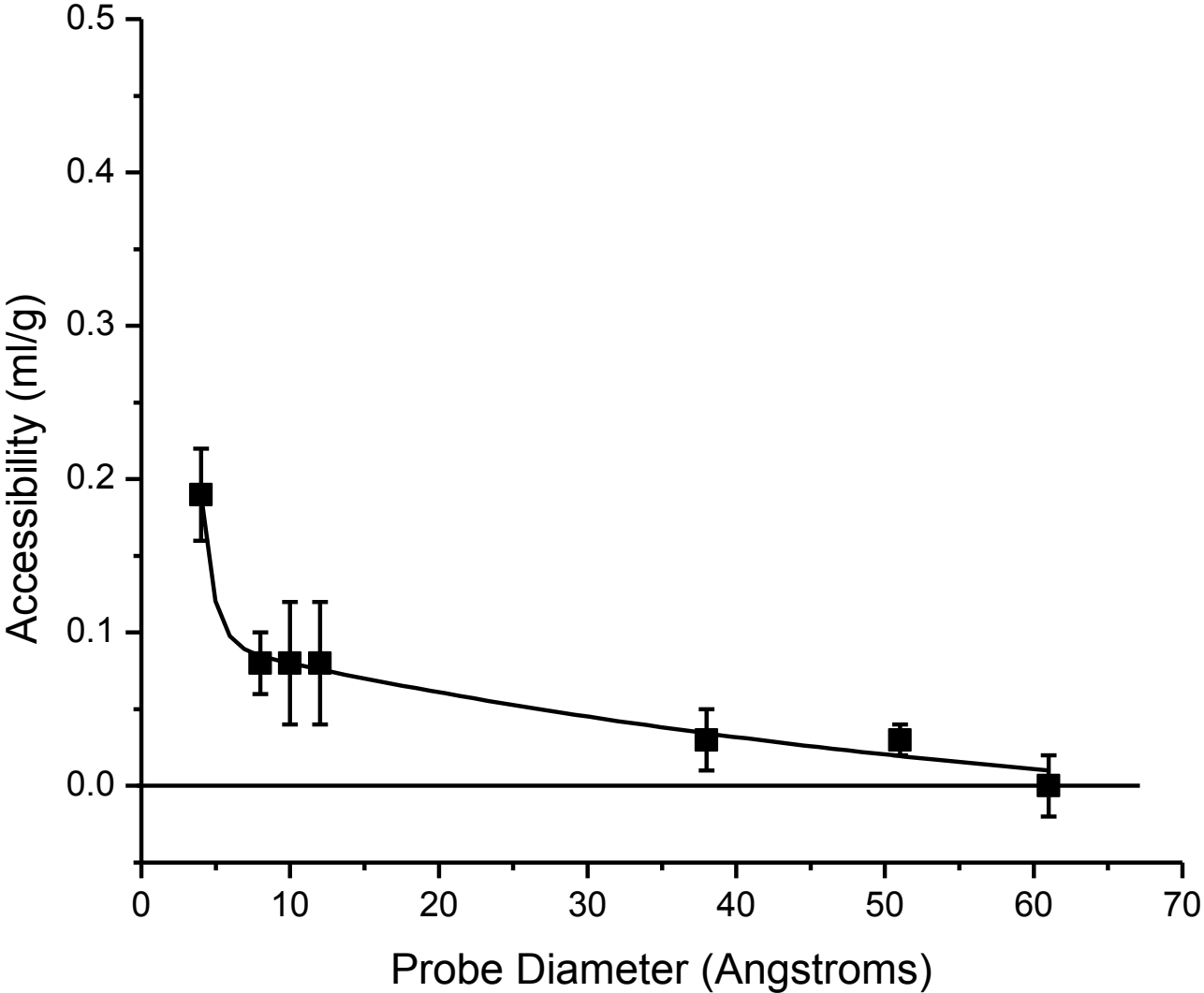
- Either cell wall bulking is not responsible for the reduction in FSP
- Or
- We are not measuring FSP when we project adsorption isotherms to 100% RH
- Stamm discussed this issue at length many years ago
- Projection to 100% RH does NOT give FSP!
- So why do so many people persist in doing this?

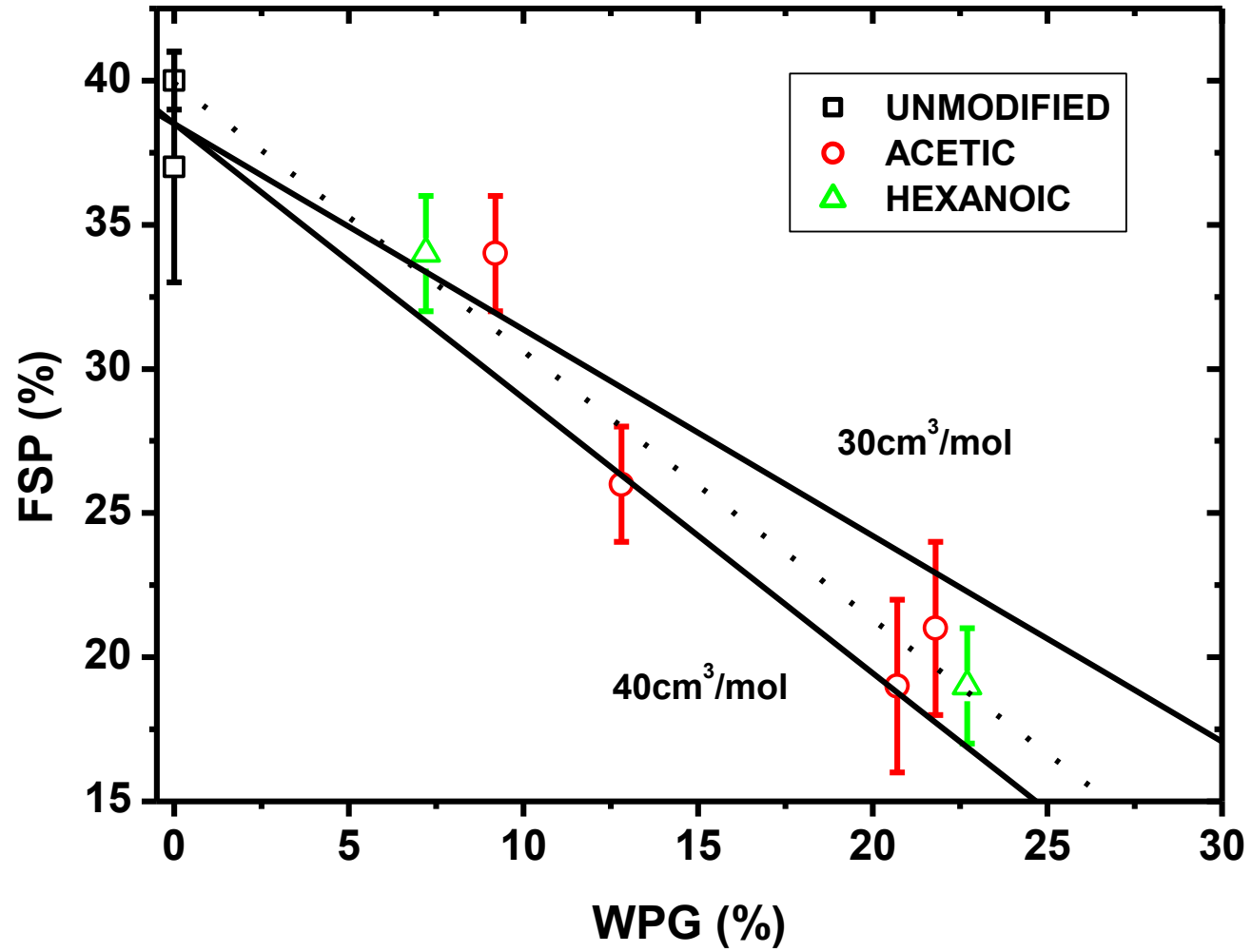
- Generally, projection methods give 'FSP' values of 25 – 30%
- What do we mean by FSP?
- Cell wall MC at saturation
- How do we know we have achieved saturation?
- With solute exclusion we know we have saturated the cell wall
- Solute exclusion gives 'FSP' of 40%



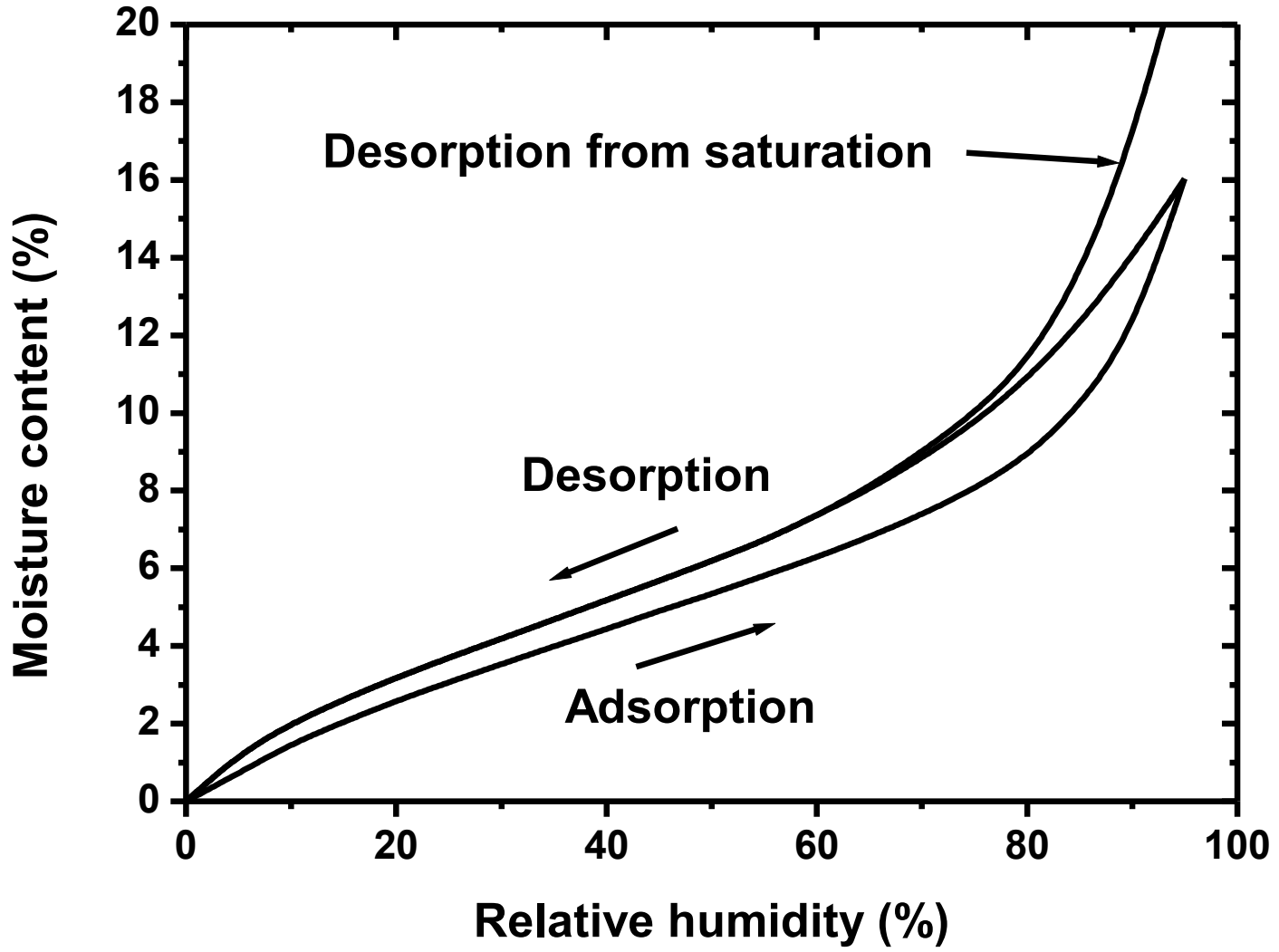








- Volume occupied by anhydride molecule in cell wall is no longer available to water molecules
- This reduces 'FSP' as determined by solute exclusion
- 'FSP' as determined by projection of adsorption isotherm does not obey this behaviour



The Centre for Timber Engineering is based at Napier University in Edinburgh. It aims to provide a support base to establish timber as a preferred material for construction through:

- Undergraduate and Postgraduate Programmes
- Continuing Professional Development Courses
- Applied and Strategic Research
- Expert Advice, Consultancy and Knowledge Transfer



<http://cte.napier.ac.uk>