



Defence Academy
of the United Kingdom

Cranfield
UNIVERSITY

EFFECT OF CRYSTALLINITY ON AGEING BEHAVIOUR OF NITROCELLULOSE

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Programme

- Crystallinity measurement of NC by XRD
- Age NC by heat and light
- Measure in-situ continuous viscosity
- Determine molecular weight by SEC
- Try to understand the effect of crystallinity on NC ageing

Experimental

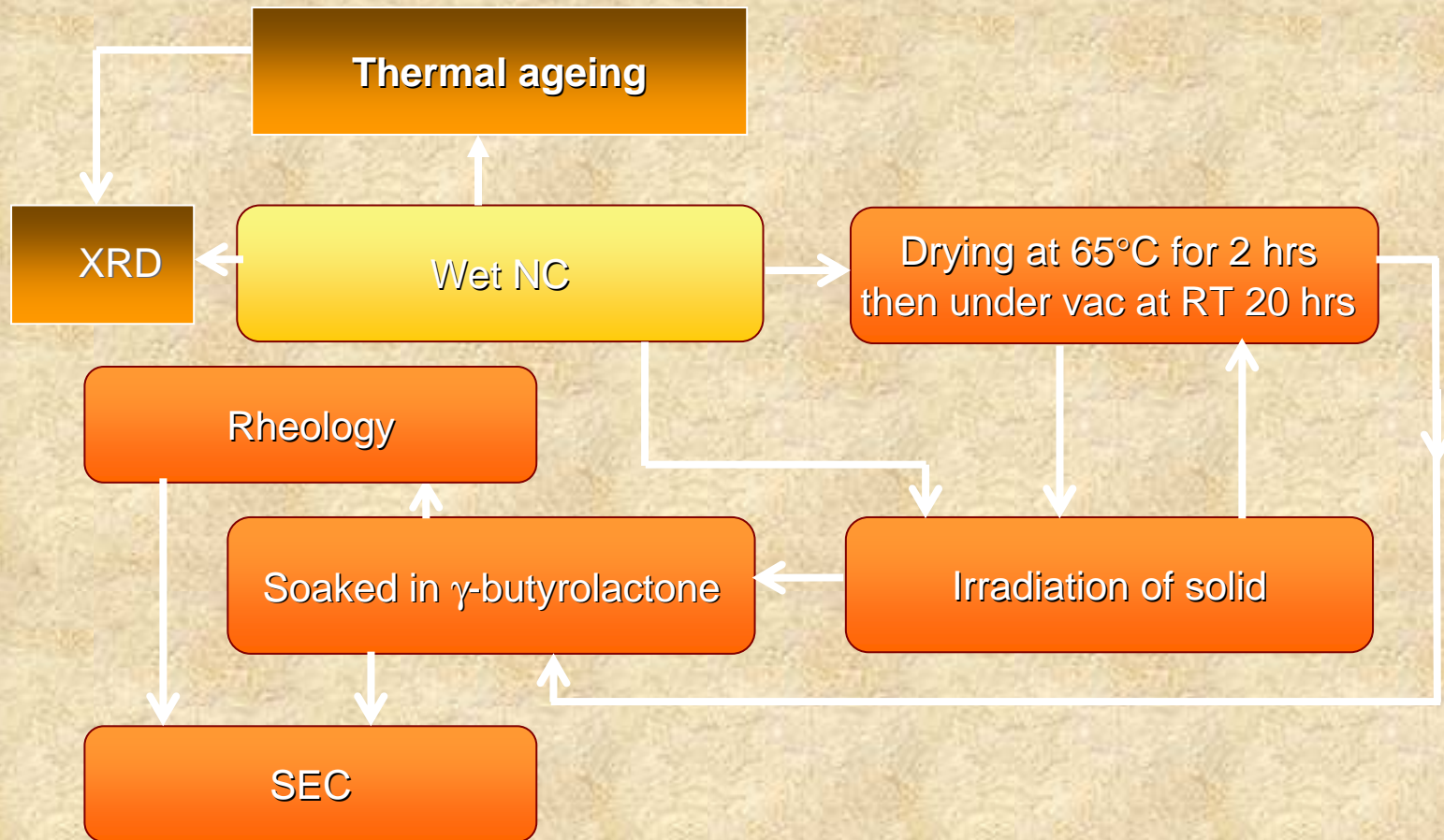
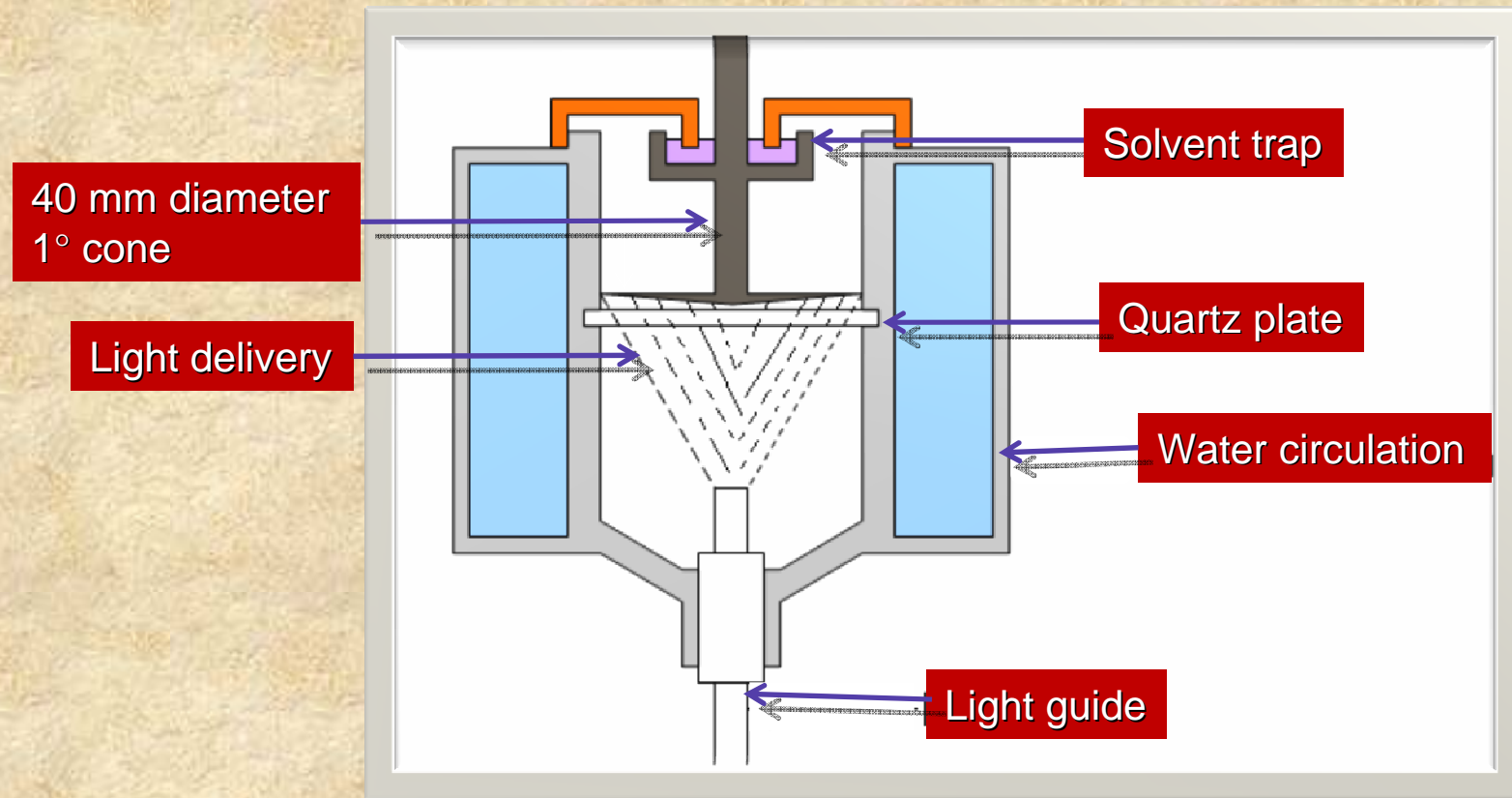


Photo-viscosity measurement

- ◆ Modified Bohlin CVOR 150
- ◆ 1°/40 mm cone and plate
- ◆ Continuous real-time measurements
- ◆ In-situ irradiation
- ◆ Controlled temperature
- ◆ Free from solvent evaporation



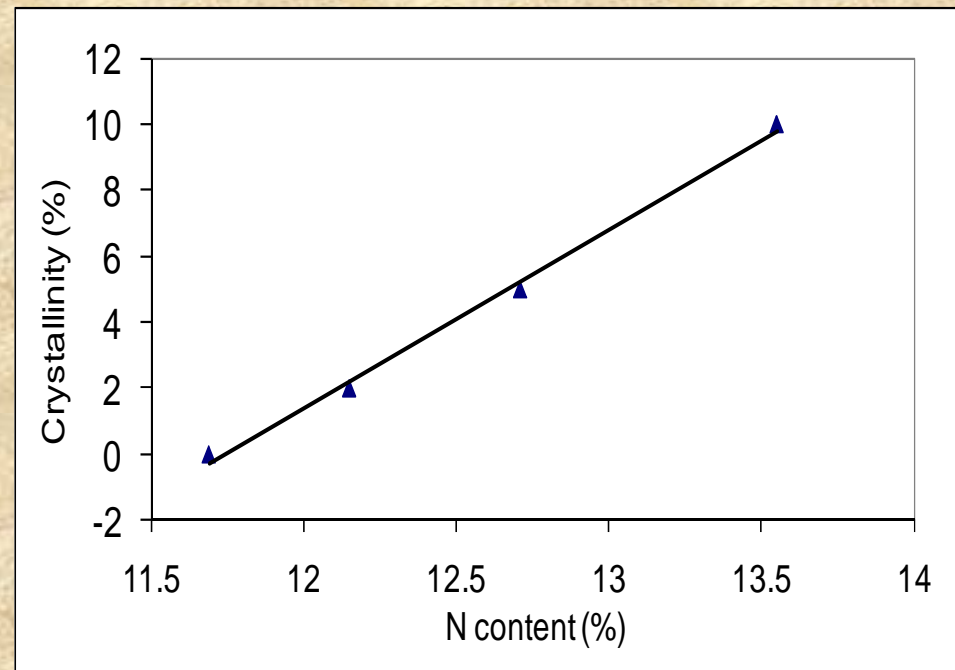
Modified sample cell



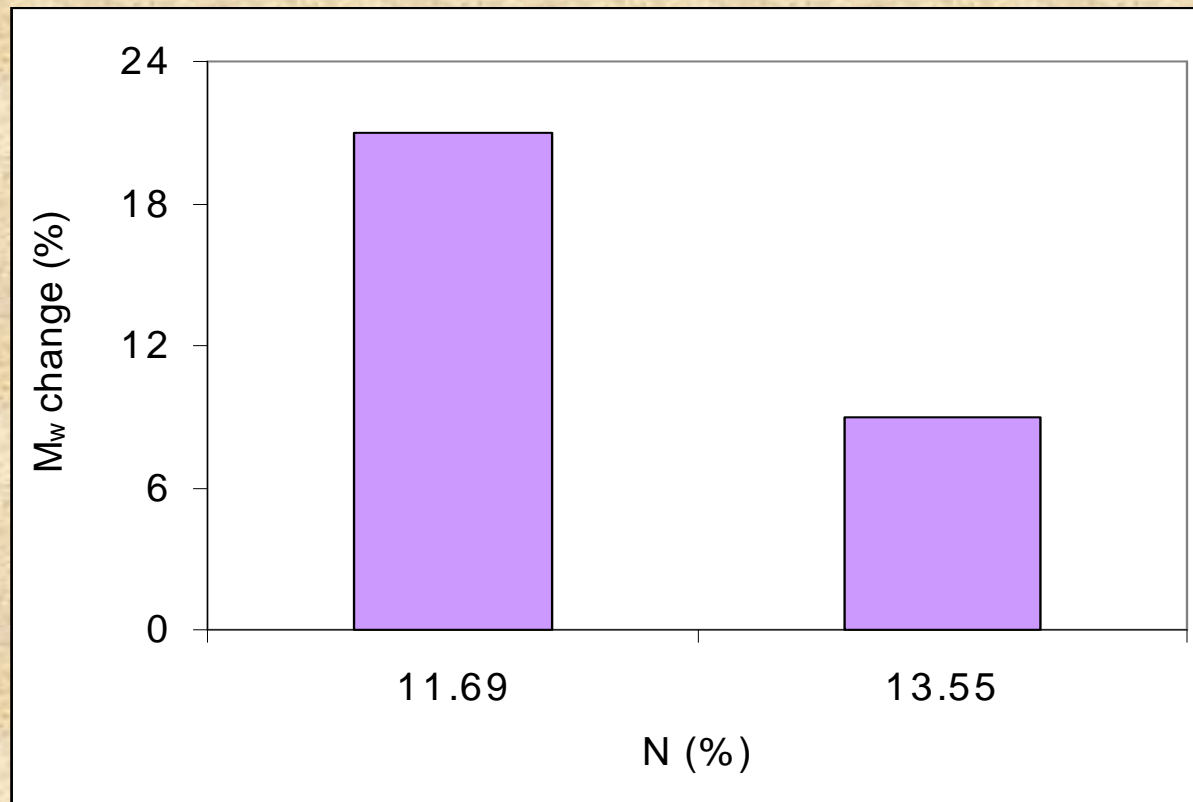
Results

Crystallinity vs N Content

- ▼ Degree of nitration dominates the degree of crystallinity

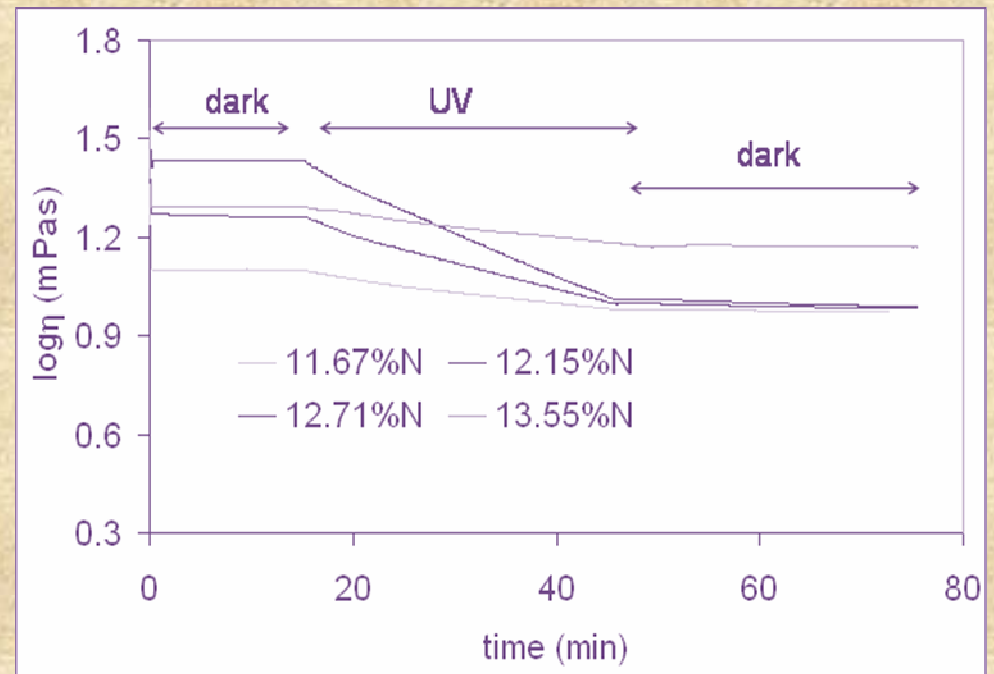


M_w Changes of thermally aged NC



Viscosities for different samples

- UV wave-length was 320-390 nm
- Concentration of 10 mg/ml
- Solution viscosity increases with increasing N content
- Exceptional viscosity behaviour for 13.55%N

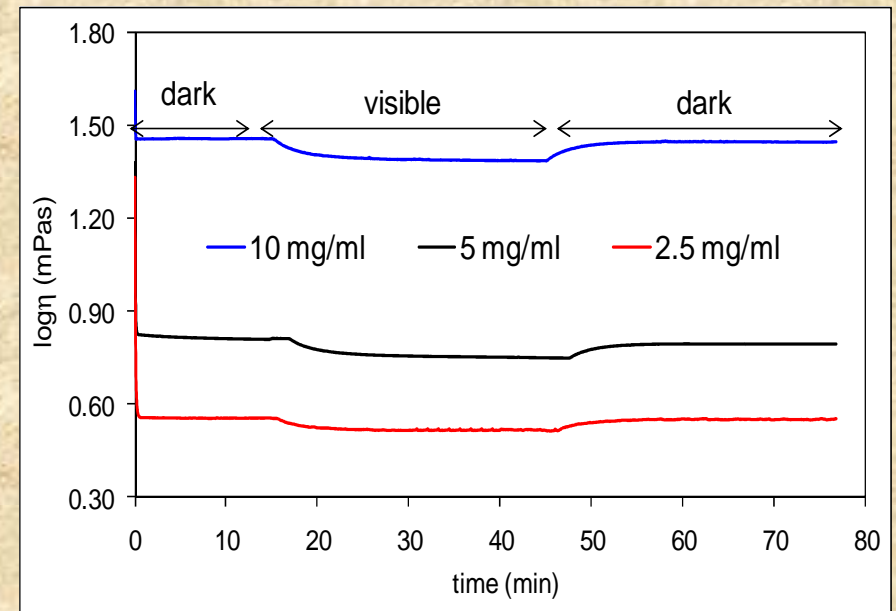


η_{sp} and M_w changes in samples

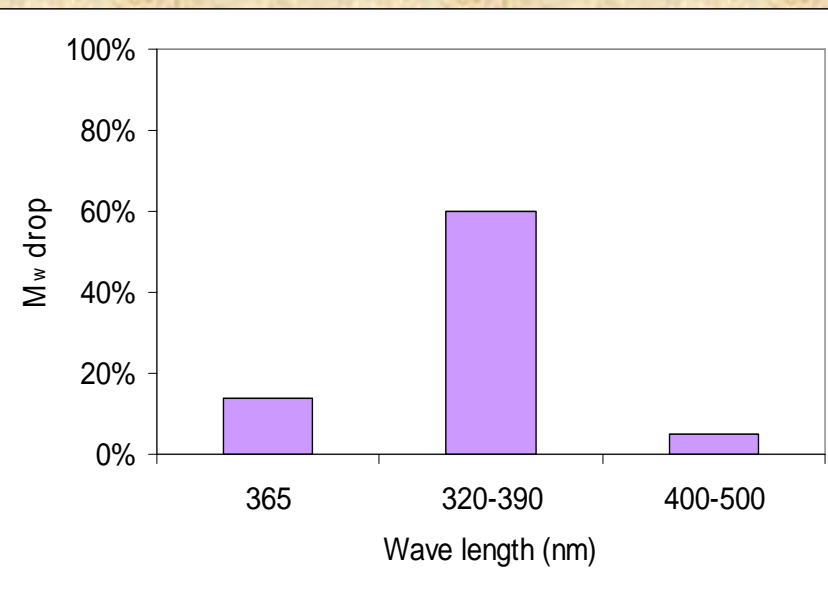
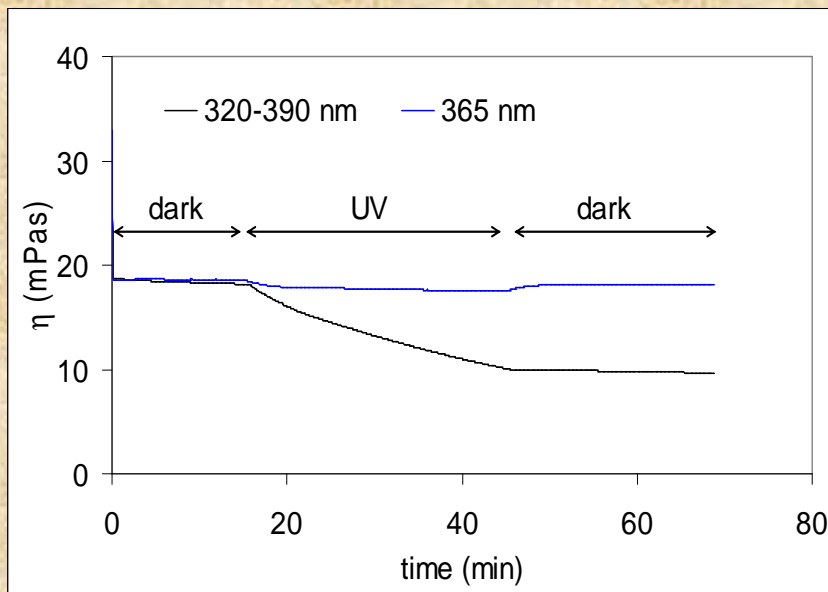
N content in NC (%)	C (mg ml ⁻¹)	M_w pre-UV (g mol ⁻¹)	M_w post-UV (g mol ⁻¹)	M_w decrease	η_{sp}/c change (%)
11.69	10	4.157×10^5	1.726×10^5	58	28
12.15	10	5.629×10^5	2.359×10^5	58	60
12.71	10	7.689×10^5	3.402×10^5	56	66
13.55	10	4.045×10^5	3.370×10^5	17	26

Effect of visible light (400–500 nm) on η and M_w

- 12.71% N content studied
- No major viscosity changes
- No significant M_w change
- η drop is due to heating effect
- Viscosity recovered after irradiation ceased

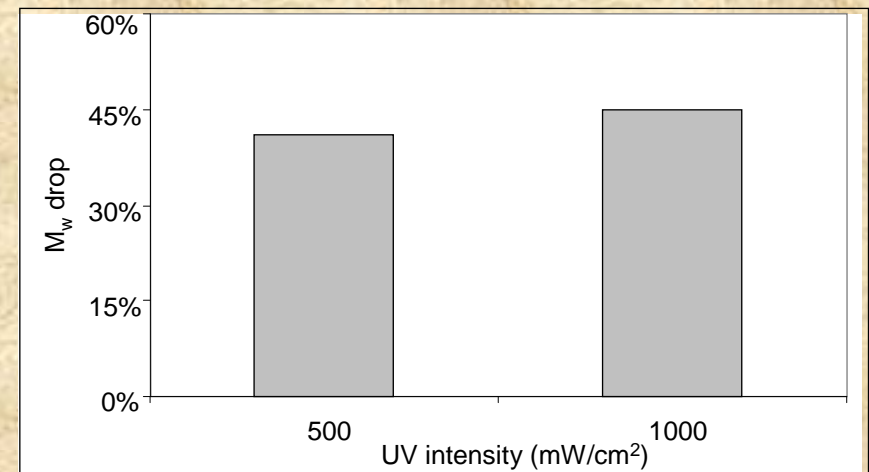
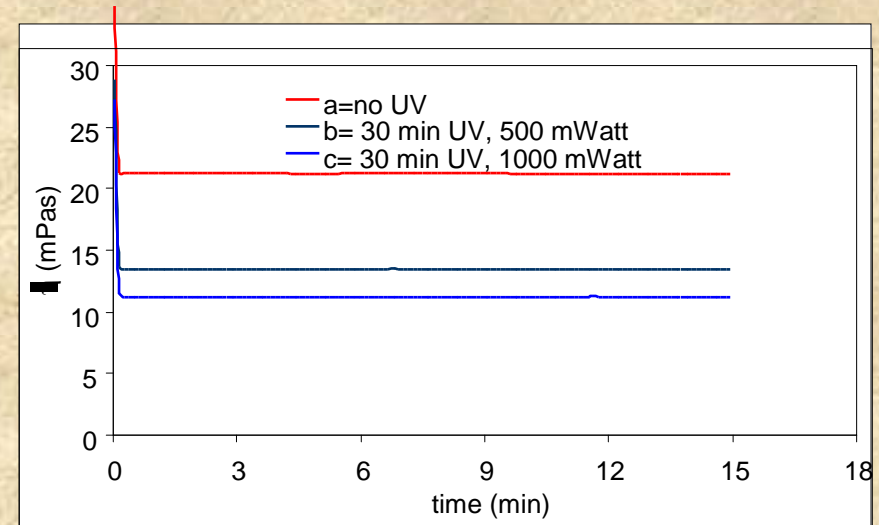


Effect of UV light on η and M_w (12.15%N)



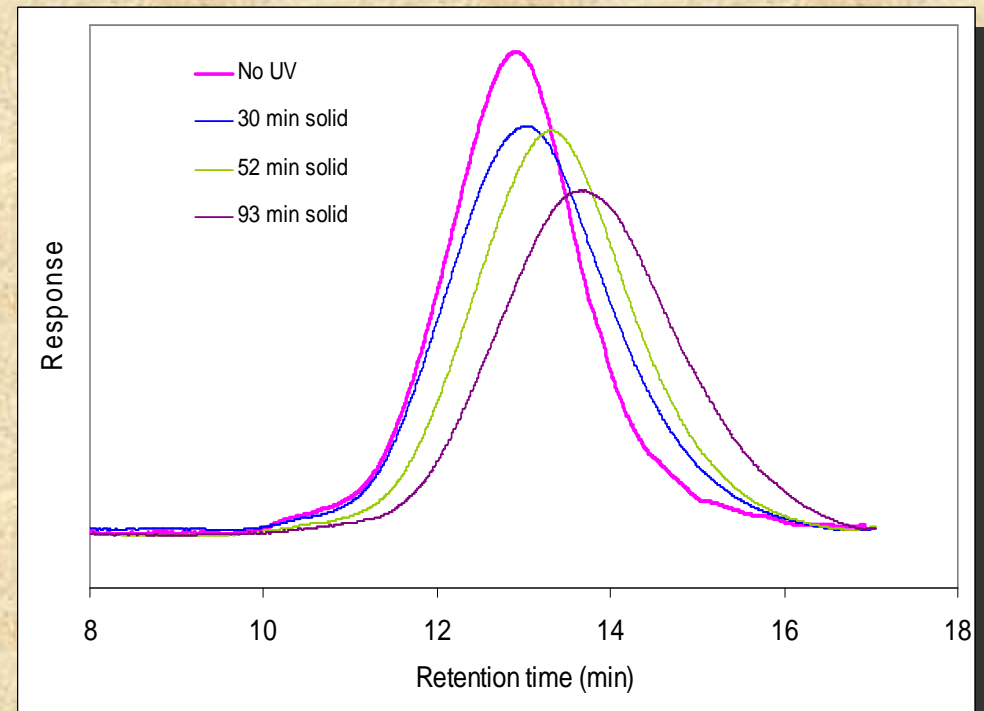
Effect of UV intensity on η and M_w (12.15%N)

- η decreases are UV intensity dependent
- M_w changes are not greatly influenced by UV intensity
- Effects are non-linear



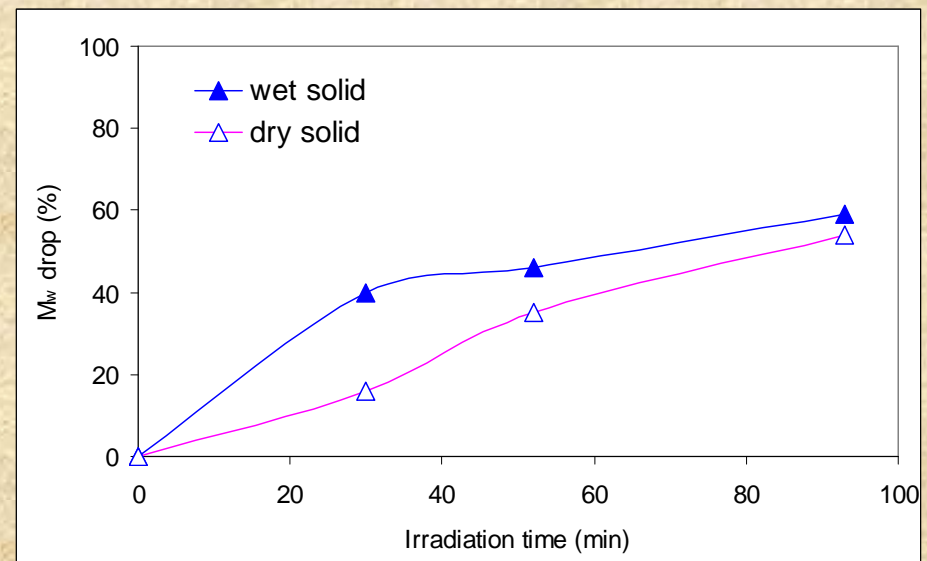
SEC of solid NC containing 12.15%N, dried (1000 mW/cm²)

- Retention time increases with UV irradiation time
- No higher M_w shoulder is observed



Changes in M_w of solid (12.15%N)

- Light intensity was 1000 mW/cm²
- Water accelerates photo-aging and M_w drop
- More acid is formed in wet NC than dry NC
- M_w drop is non-linearly dependent on irradiation time



Conclusions

- Crystallinity is linearly dependent on N content in the NC
- M_w changes of thermally aged NC is significantly influenced by crystallinity
- In-situ photo-viscosity measurement with modified rheometer gave better results with good precision than a conventional method
- UV irradiation causes NC chain scission and hence drop in η but not at 365 nm
- Visible light shows no effect apart from small amount of heating
- η and M_w decrease faster in wet NC than in dried NC

Acknowledgement

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