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Styling Hair Naturally

Revolymer Personal Care

Rocio Perez, Julie Bacon, Neil Kilcullen

2nd September 2016

Outline

- RevCare NE 100S – Polyitaconic Acid (NK)
- Characteristics of Hair Styling Agents (NK)
- Efficacy Studies (RP)
  - High Humidity Curl Retention
  - Combability
  - Curl Stiffness
  - Anti-Frizz
- Summary & Conclusions (NK)

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RevCare NE 100S

Polyitaconic Acid

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Background

- “Natural” and “Naturally-Derived” are enduring concepts in Personal Care
- Hair Styling is a major category in Personal Care
- There are few natural hair styling polymers available currently

Market Opportunity

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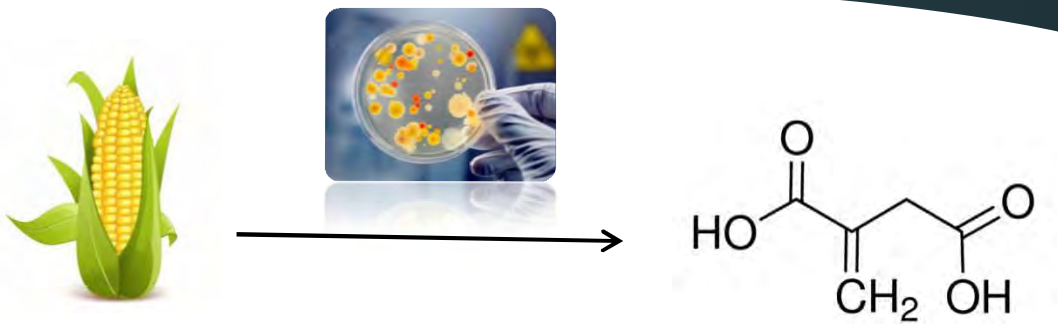
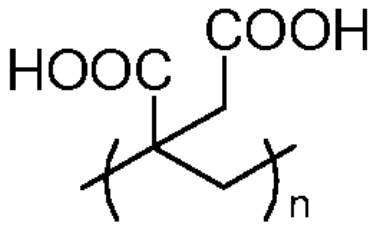
Polyitaconic Acid: Characteristics



- Itaconic Acid
  - Naturally occurring
  - Non-toxic
  - Readily biodegradable
  - Produced on an industrial scale by fermentation (e.g. glucose) with Aspergillus terreus

- Polyitaconic Acid
  - Film forming polymer
  - Properties can be tailored via the degree of neutralisation
    - Hydrophilic / hydrophobic balance
    - Hold / flexibility balance
    - Hold / wash-out balance



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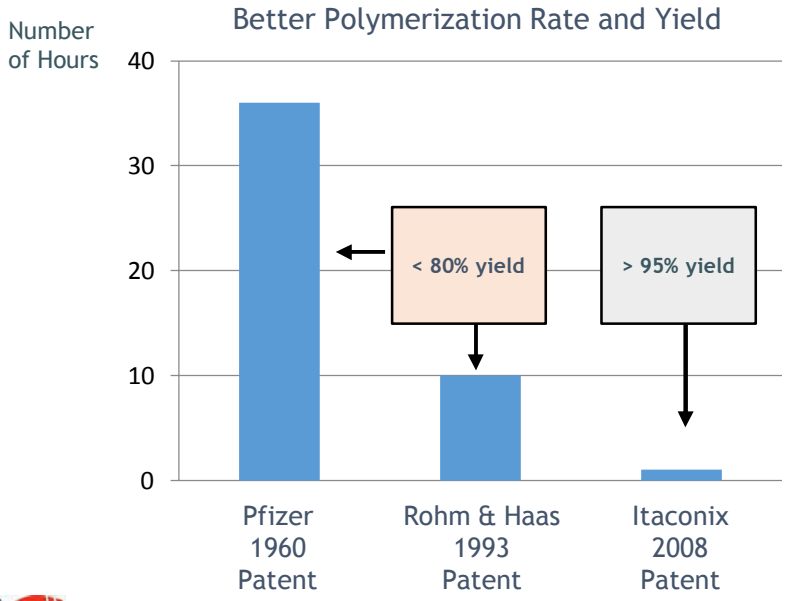
Polyitaconic Acid: Manufacture

- Method of Polymerisation (US 7,920,676)
  - Polymers are prepared under selected conditions of partial neutralisation
  - High conversion rate
- Continuous Production (US 8,420,758)
  - Exothermic heat from the polymerisation reaction
  - Endothermic heat transfer from solvent (water) evaporation



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Characteristics of Hair Styling Agents

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Characteristics of Hair Styling Agents

- Function
  - Build inter-fibre forces to maintain the desired configuration or shape
- Consumer Expectations
  - Style held firmly over extended periods of time and exposure to environmental conditions
- Requirements
  - Uniform application
  - Clear layer
  - Hair appears natural – and glossy
  - Hair feels natural - not tacky, not too stiff
  - Hair easily combed (wet and dry)
  - Product readily removed during washing

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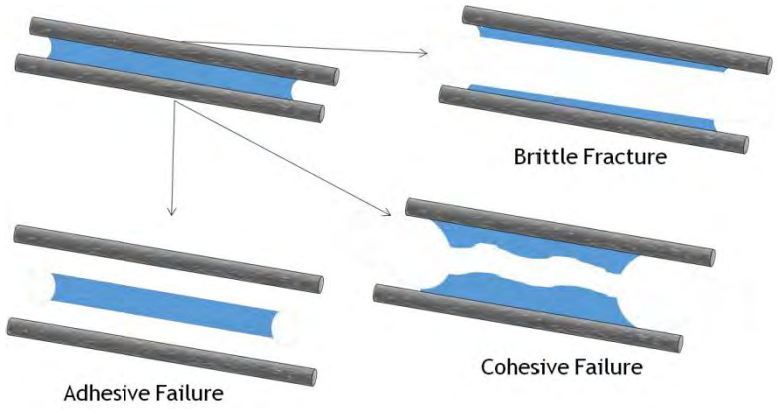
Hair Fibre Welds

- Hair styling polymers function by forming seam welds and spot welds between adjacent fibres in a hair array
- Strong forces are exerted on the welds as a result of hair movement
- Styling polymers must form durable films which adhere to hair fibres strongly otherwise welds will undergo:
  - Brittle fracture – film is too hard and glassy
  - Cohesive failure – film is too soft or rubbery
  - Adhesive failure



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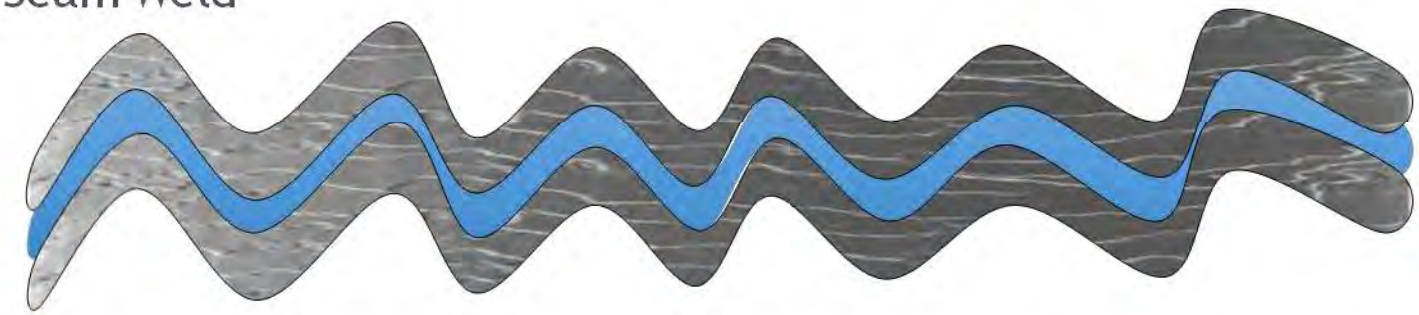
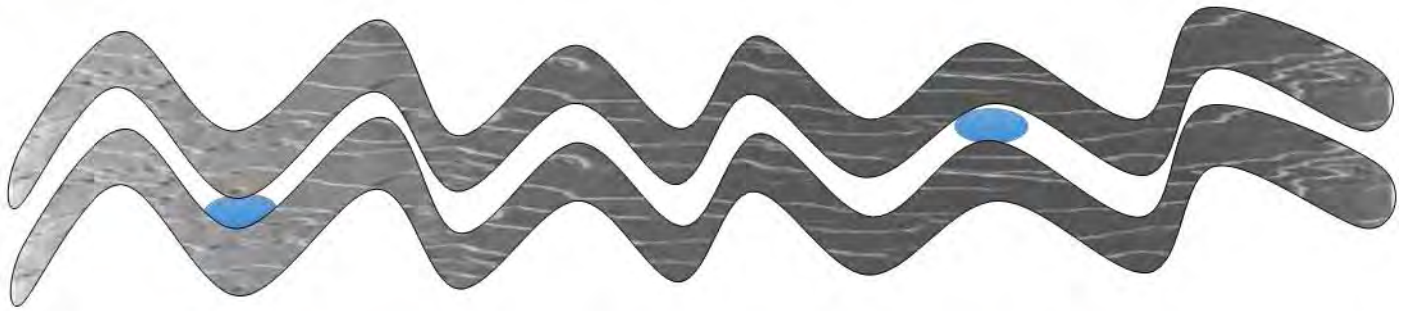
Bending Modulus of Hair

Seam Weld



The bending modulus is that of the composite

Spot Weld



Natural bending modulus of the hair is retained

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Efficacy Studies

High Humidity Curl Retention

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Style Retention: Method

- Tresses are wetted
- Product is applied – wet applied and combed through
- Tresses are styled and air-dried overnight
- Tresses are placed in a humidity chamber at 35°C/85% RH

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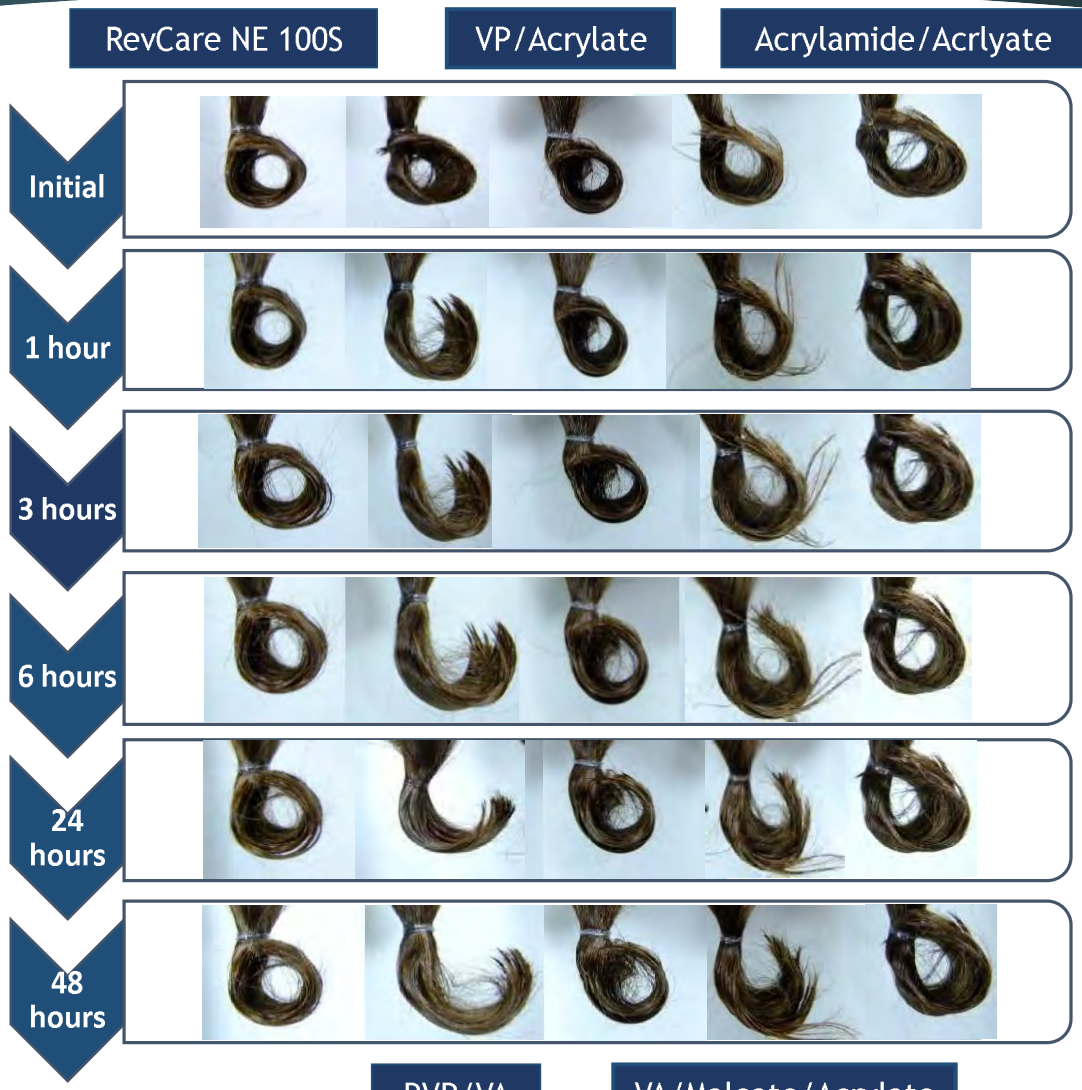
Style Retention: Results



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Observations & Conclusions

- In a high humidity environment polymer films will absorb water. Films that are too hygroscopic will over plasticise and fail.
- Tresses treated with RevCare NE 100S retain their configuration demonstrating a resistance to over plasticisation and weld failure
- RevCare NE 100S outperforms the PVP/VA benchmark and is at least as effective as leading synthetic styling polymers

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Combability

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Comb Resistance: Method

- Tresses are wetted
- Product is applied
- Tresses air-dried overnight
- Force required to comb the tresses is measured using a hair combing rig attached to a texture analyser

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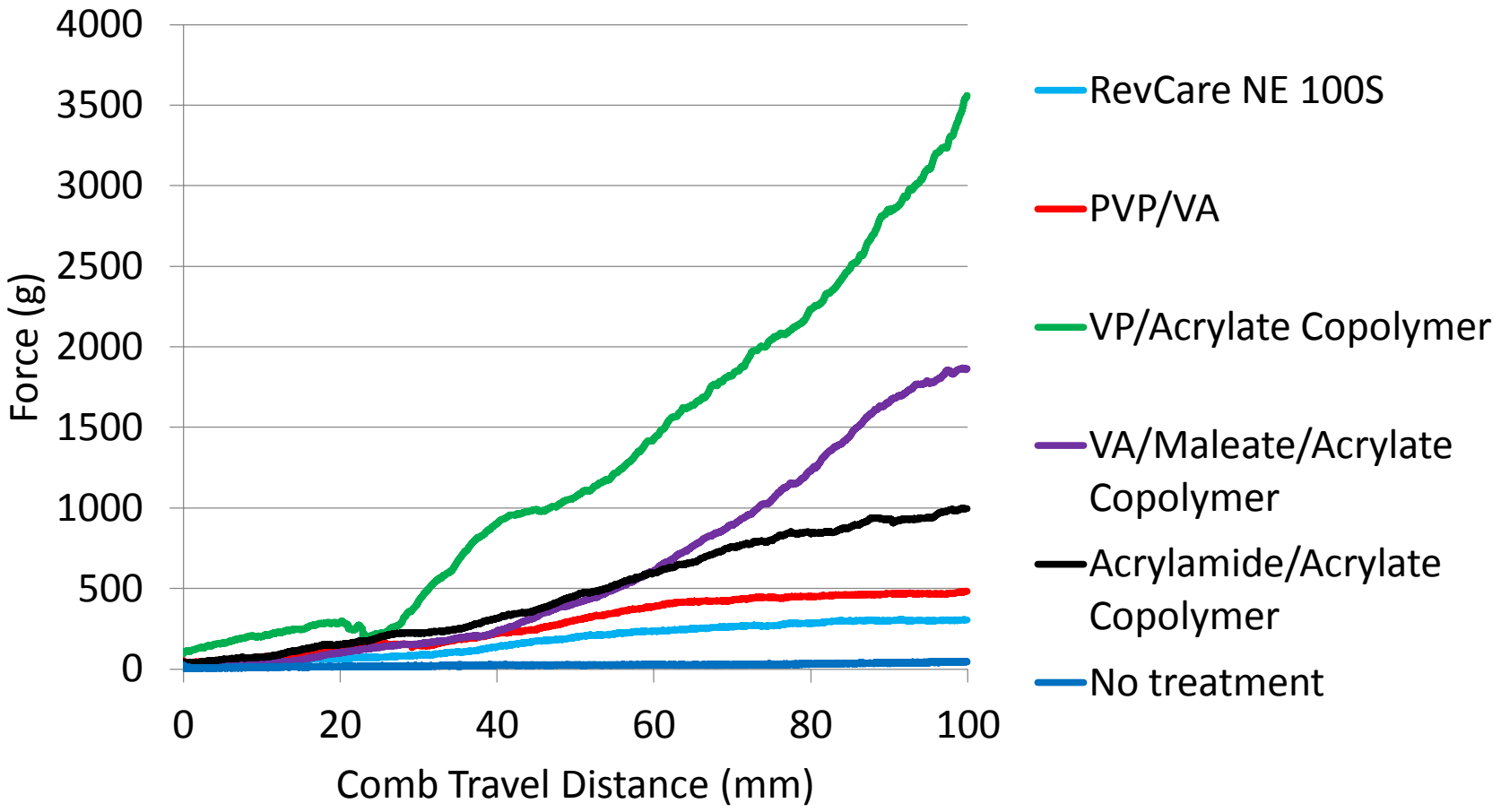
Comb Resistance: Results (First Cycle)



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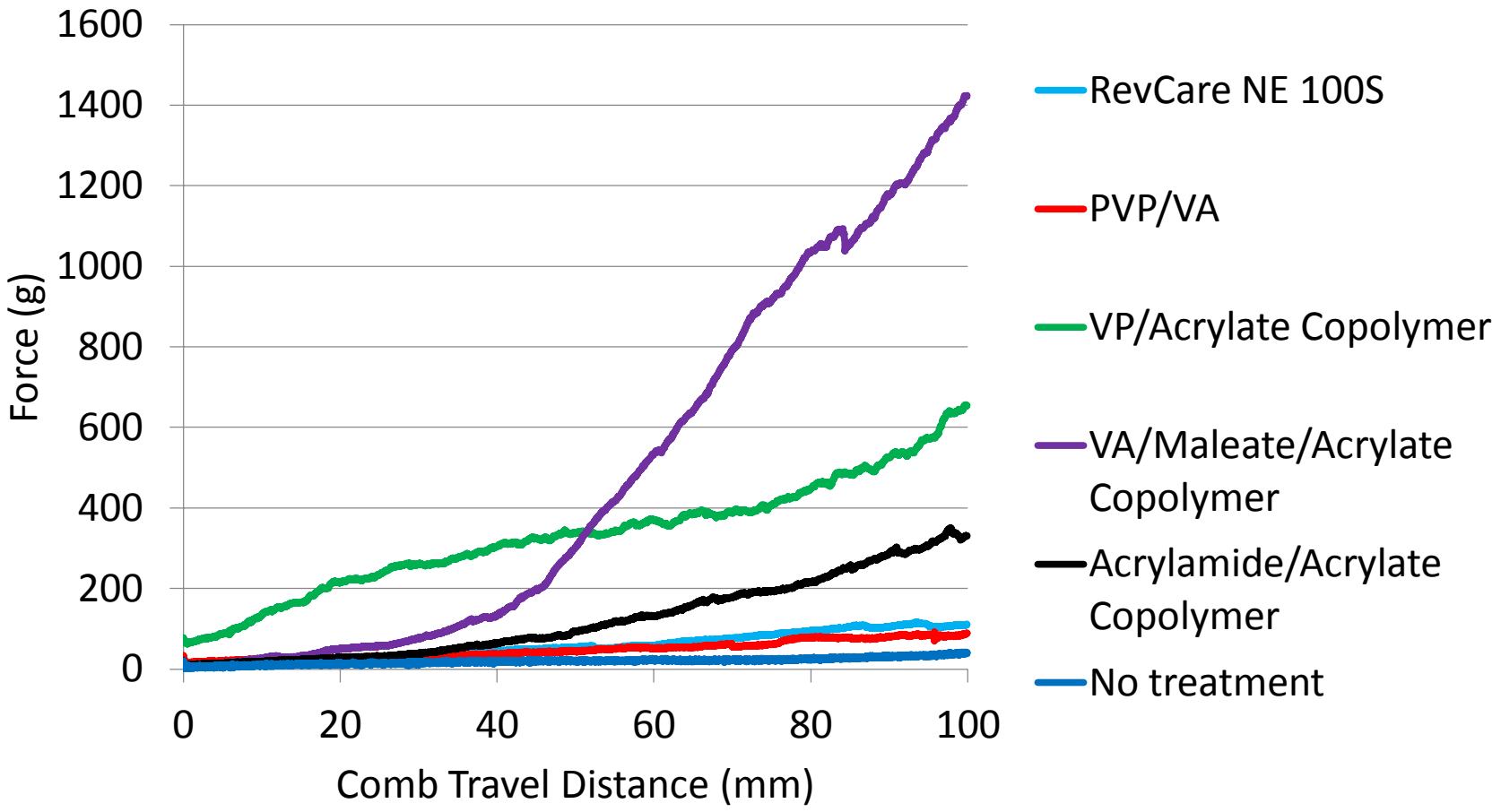
Comb Resistance: Results (Second Cycle)



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Observations & Conclusions

- The force required to comb styled hair depends on how the fibres interact – styled hair requires a larger force
- The greater the degree of welding (seam welds, number of spot welds) the larger the combing force
    - VP/Acrylate copolymer predominantly seam welds - first cycle highest force, second cycle notable reduction in the combing force
    - VP/Maleate/Acrylate copolymer welds more flexibly – lower force differential between 1st and 2nd cycles
    - RevCare NE 100S and PVP/VA weld lightly – comb force is low and tends towards no treatment

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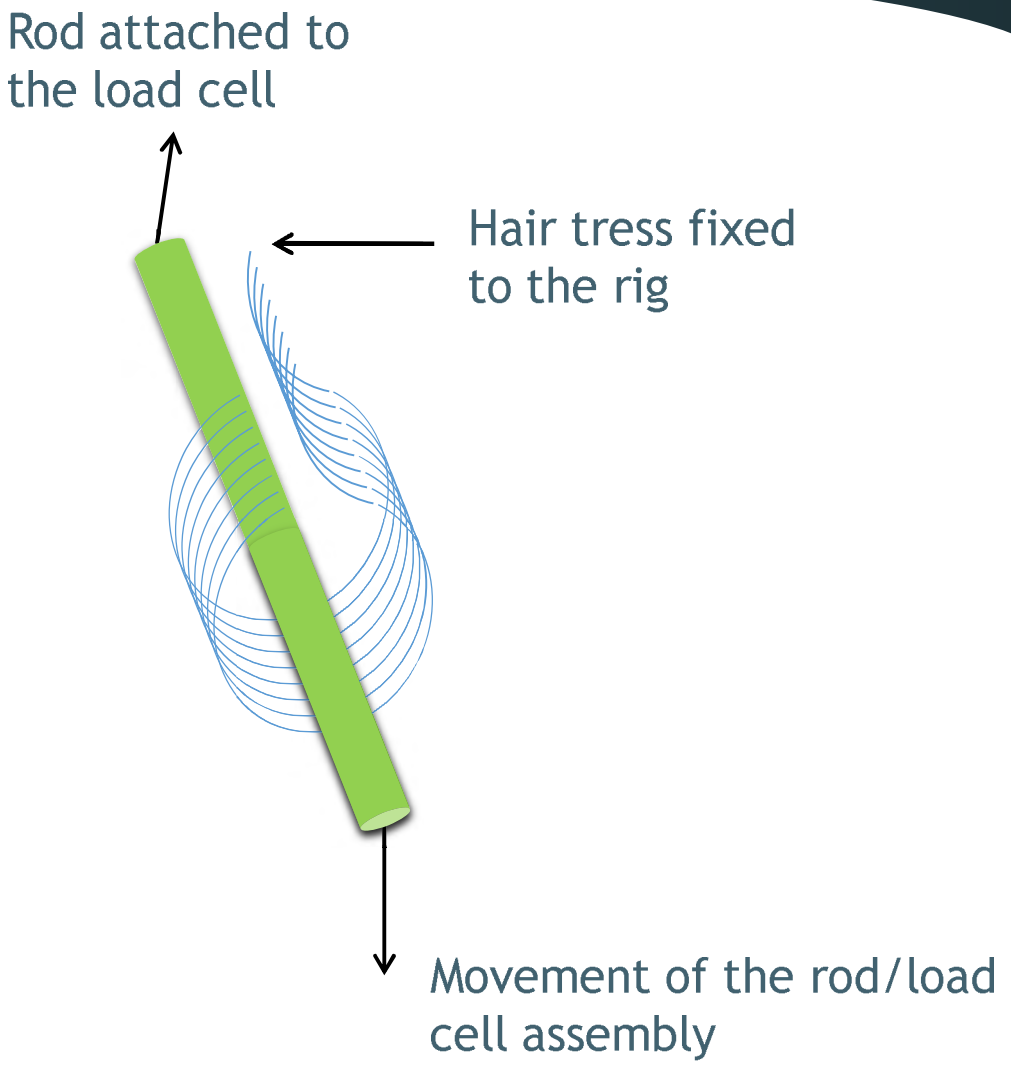
Curl Stiffness

Style Flexibility: Method

- Tresses are wetted
- Product is applied
- Tresses air-dried overnight
- Force required to flick a curl with a metal rod is measured using a modified hair combing rig attached to a texture analyser



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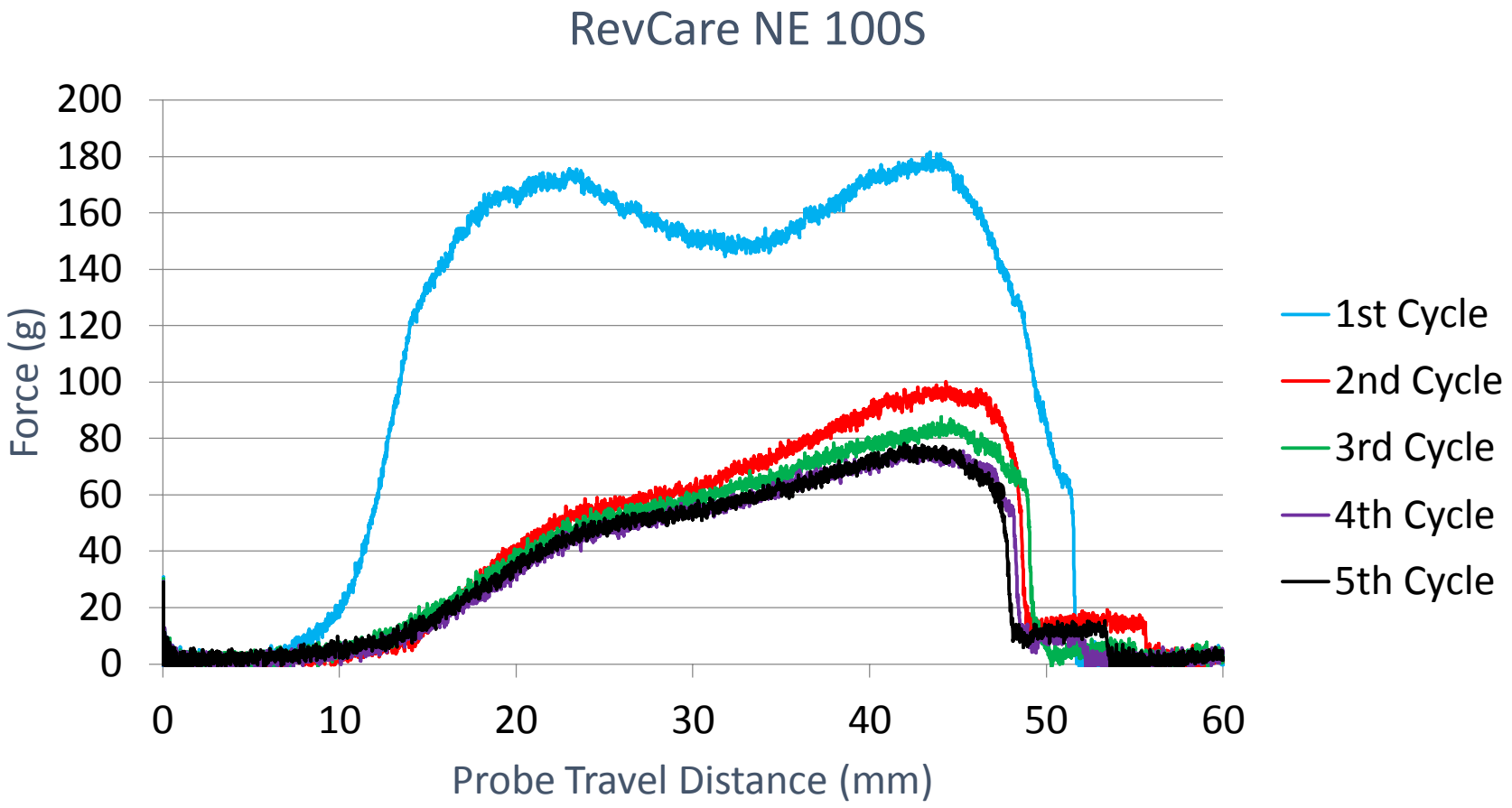
Style Flexibility: Results



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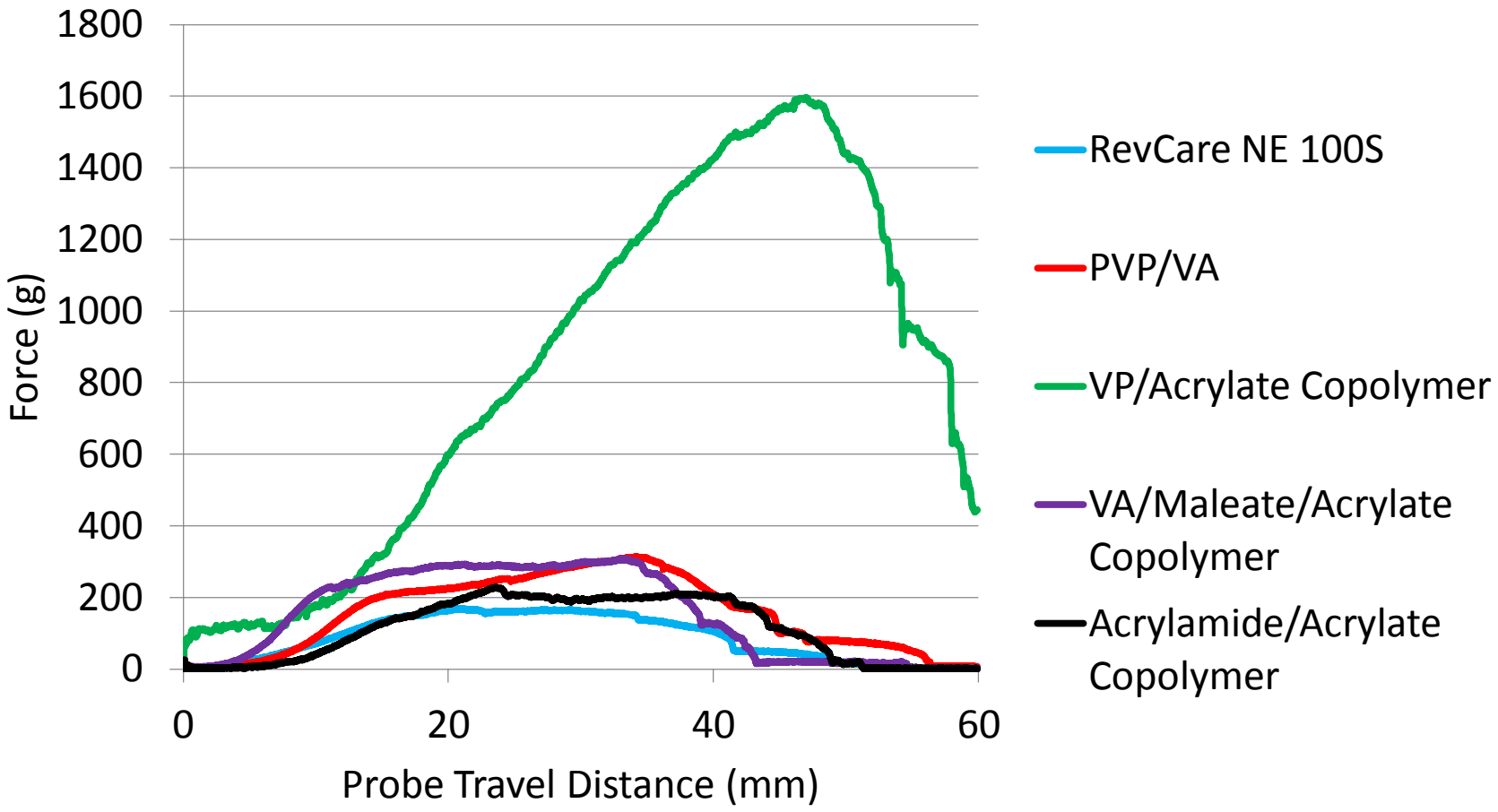
Style Flexibility: Results (First Cycle)



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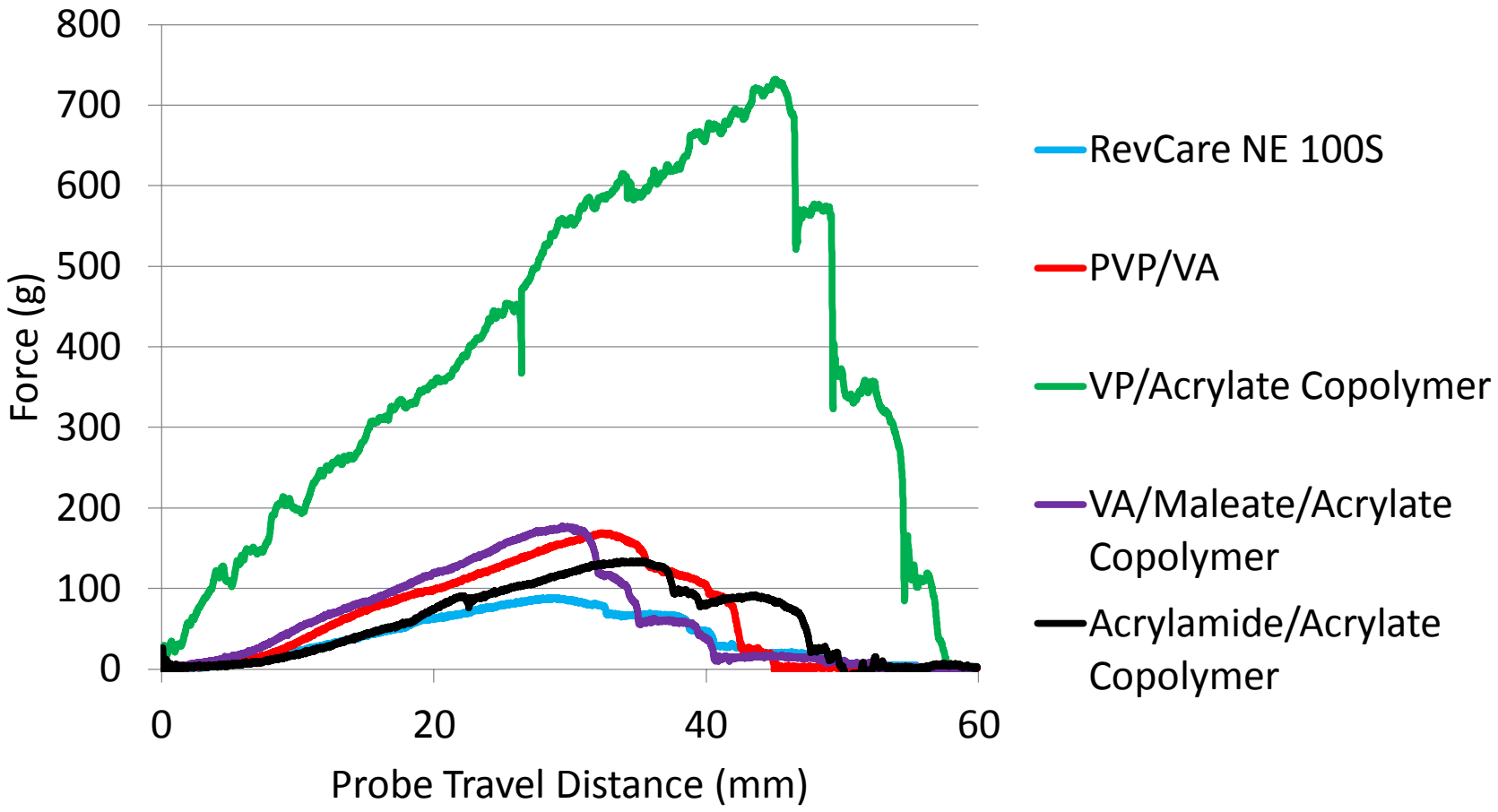
Style Flexibility: Results (Second Cycle)



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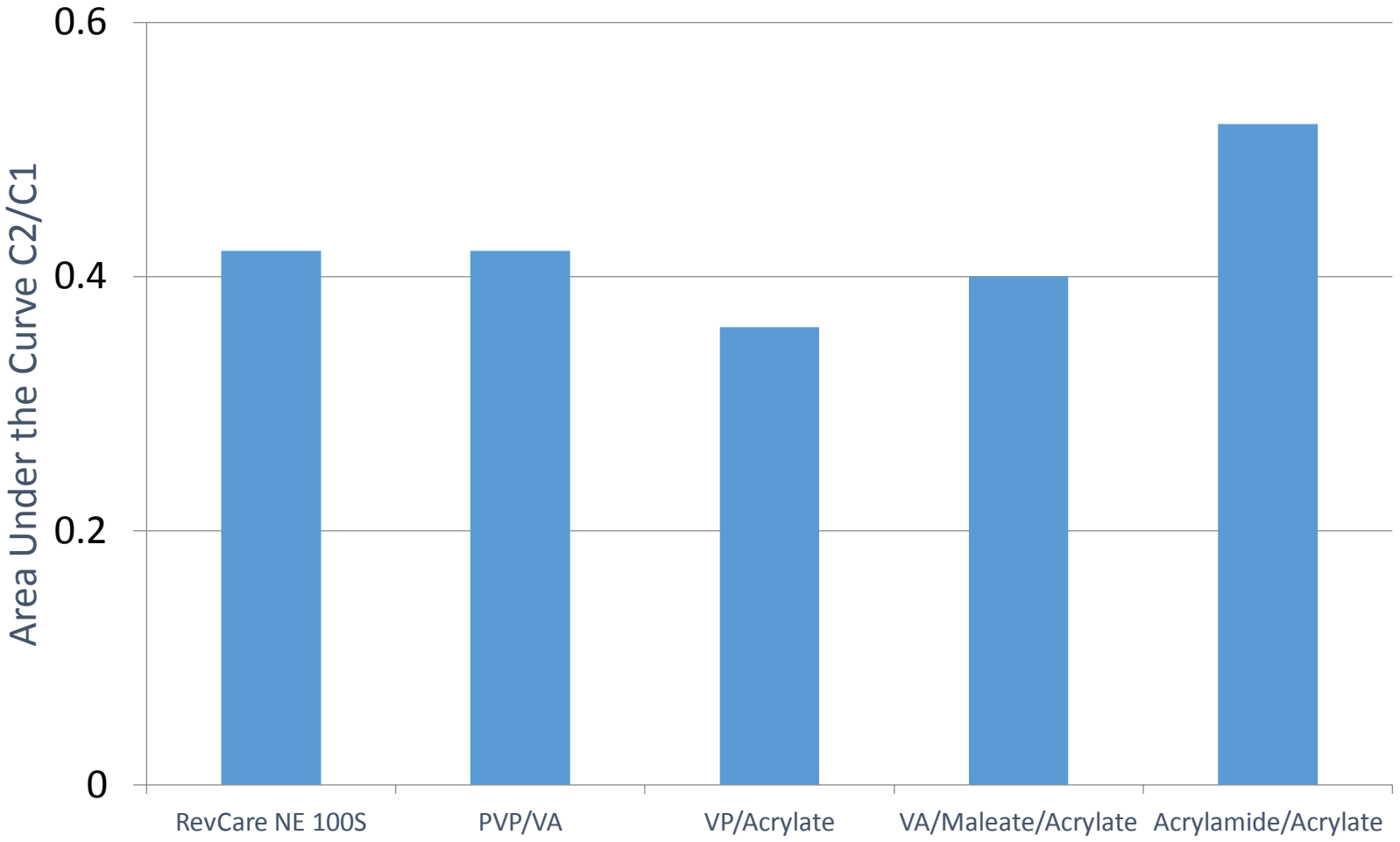
Flexibility Ratios



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Observations & Conclusions

- For styled hair, bending the array exerts forces on the polymer film leading to some weld failure - subsequent bending requires less force
- The bending force required gives an indication of the inherent softness of the hold
- Differences in forces required in consecutive bending cycles are an indication of the flexibility of the polymer film
- RevCare NE 100S delivers a relatively soft hold and has good flexibility

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Anti-Frizz

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Frizz Control: Method

- Tresses are wetted
- Product is applied
- Tresses air-dried overnight
- Tresses are placed in a humidity chamber at 25°C/85% RH

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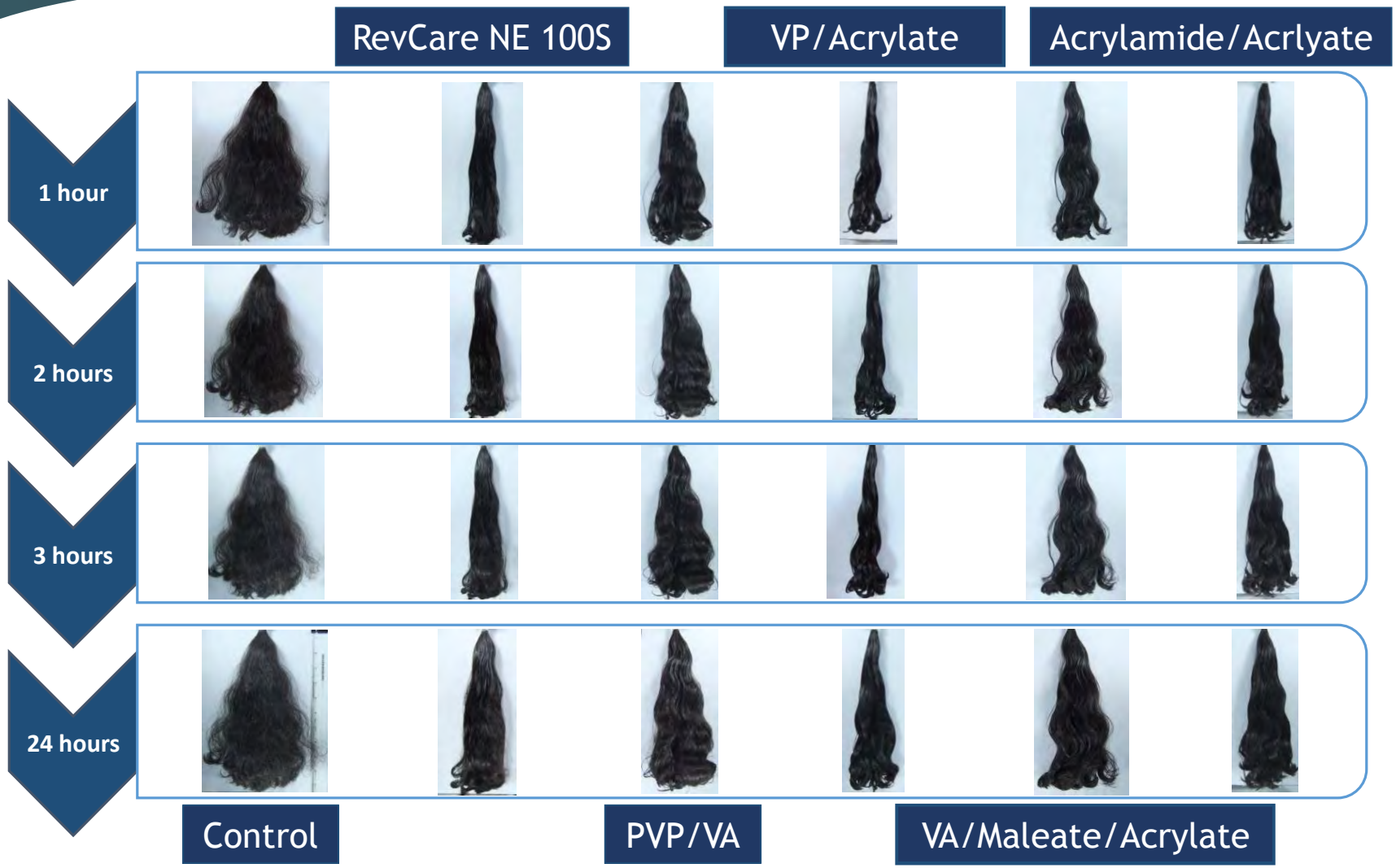
Frizz Control: Results



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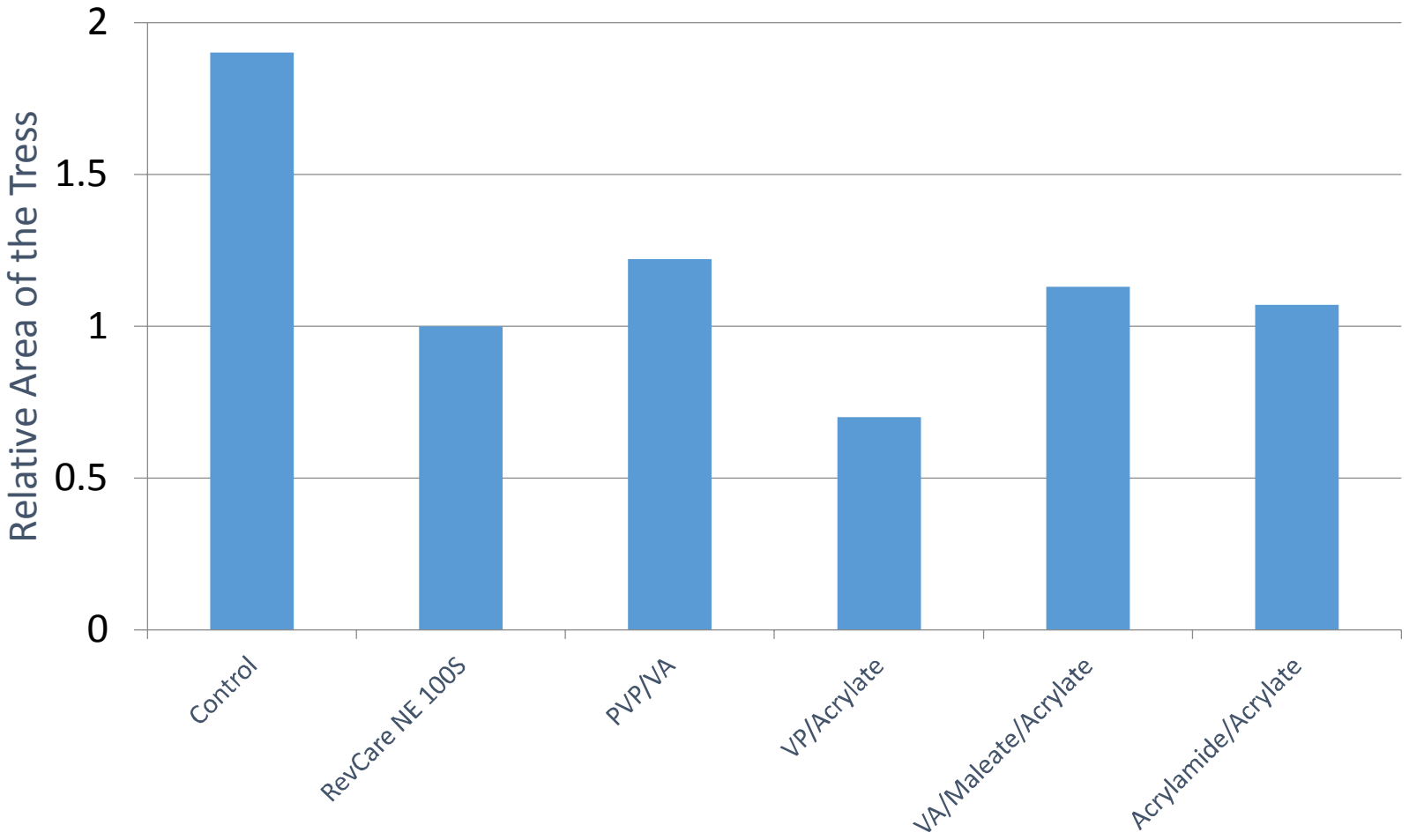
Frizz Control: Image Analysis Ratios



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Observations & Conclusions

- Hair becomes frizzy owing to hydrogen bonds between adjacent fibres being broken
- Styling polymers supplement the degree of inter-fibre bonds
- This bonding is diminished gradually as the polymer film hydrates and plasticises
- RevCare NE 100S bonds hair lightly but is resistant to plasticisation helping to prevent frizz

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Summary

Summary

- Styling polymers form welds between adjacent fibres in a hair array
  - Seam welds → bending modulus is that of the composite
  - Spot welds → natural bending modulus of the hair is retained

- Styling polymers must form flexible durable films
  - The bending force → softness of the hold
  - Consecutive bending cycles → flexibility of the polymer film

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Summary

- In a high humidity environment polymer films will absorb water
  - Hygroscopic films → over plasticise → fail
- Hair becomes frizzy owing to hydrogen bonds between adjacent fibres being broken
  - Styling polymers → inter-fibre bonds → anti-frizz

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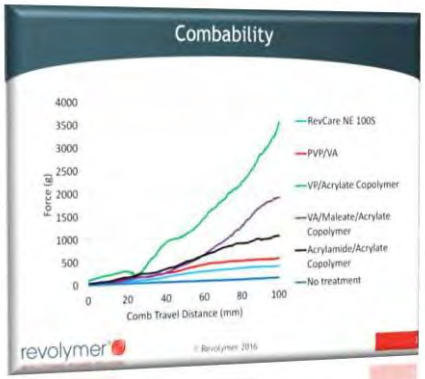
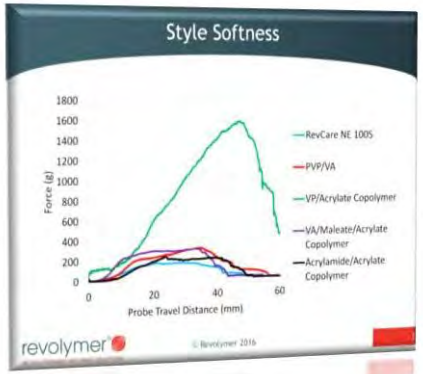
Summary

- RevCare NE 100S (Polyitaconic Acid)
  - Resistant to over plasticisation and weld failure
    - Retains its configuration in a high humidity environment
  - Welds lightly
    - Delivers a relative soft hold and good flexibility
    - Required combing force is low
    - Functions well as an anti-frizz agent





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Revolymer (U.K.) Ltd
1 Newtech Square
Zone 2, Deeside Industrial Park
Deeside
Flintshire, UK
CH5 2NT

Tel: +44 (0) 1244 283 537
Email: neil.kilcullen@revolymer.com

Tel: +44 (0) 1244 283 540
Email: rocio.perez@revolymer.com

www.revolymer.com

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