Behavior of Micro-Stickies in Papermaking Environment

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Outline

- **Background of micro-stickies**
- **Objectives of research**
- **Experiments & Discussion**

  --- Charge determination of model micro-stickies

  --- Stability of micro-stickies (no fibers)

  --- Interactions between micro-stickies and fibers
- **Conclusions**
- **Future work**

Micro-Stickies

- What are micro-stickies?

  -- Can pass through 0.006” (about 125μm) slotted screen

  -- Defined as a size less than 100 μm

- Problems associated with micro-stickies

  -- Can agglomerate and deposit on the wires and felts

  -- Affect the paper properties and appearance

What Affects the Formation of Micro-Stickies ?

- Mechanical action in the pulper or other equipment.
- Materials that detackify adhesive contaminants promote the formation of micro-stickies.
- Some adhesives applied to the paper are already in a small, discrete size

Micro-Stickies Previous Research

- **R.Klein and H. Grossmann (1997)**

  Discussed difficulty in the measurements and investigated the effects of cationic polymers on different micro-stickies
- **I. M. Hutten and Sujit Banerjee (1997)**

  Micro-stickies will agglomerate in pure water but fibers inhibit this process
- **B. Carre and J. Brun (1996)**

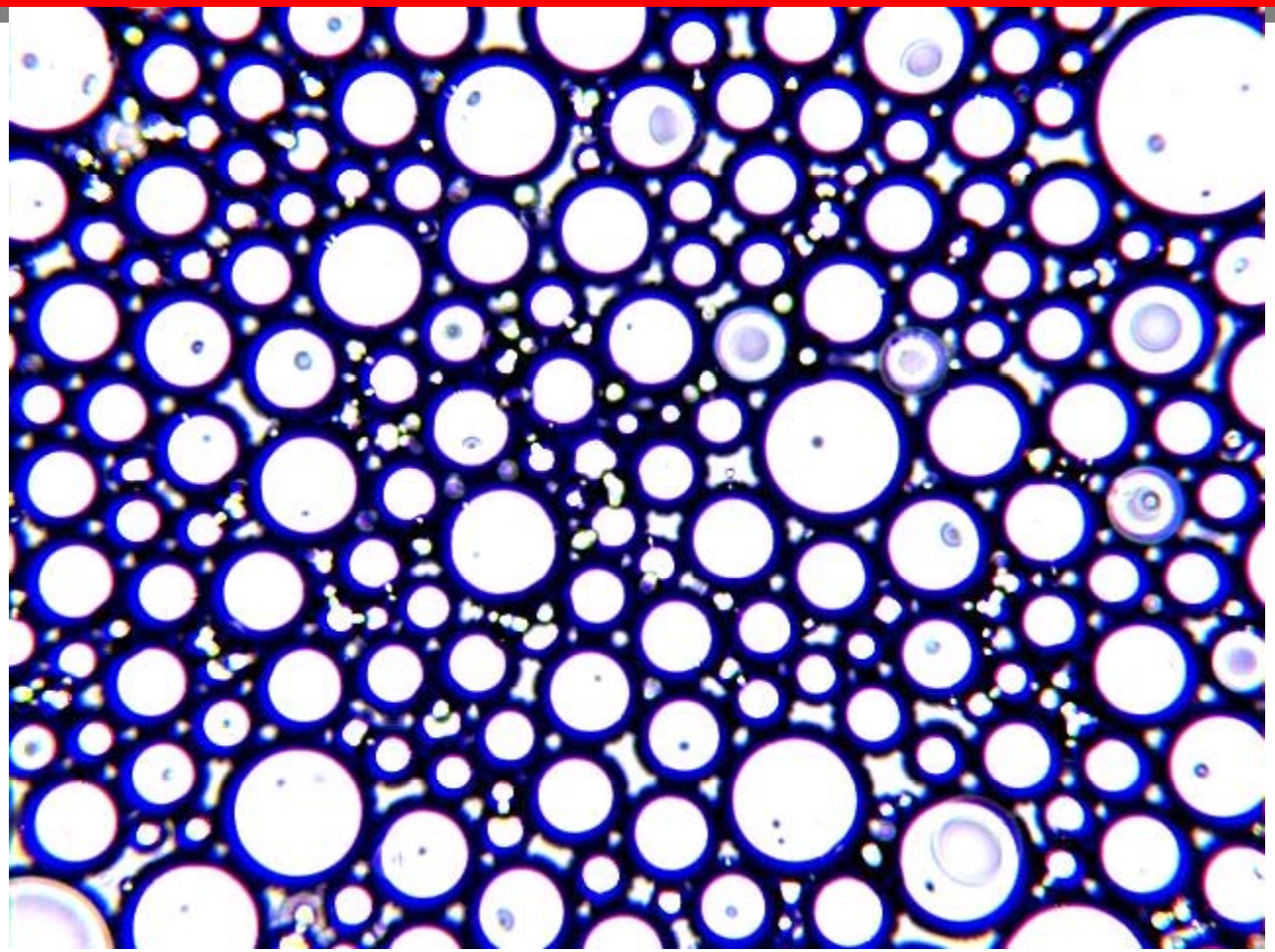
  Maximum deposition of micro-stickies occurred at charge neutral point of the entire system
- **A. Setter (1993)**

  Micro-stickies can be removed from white water by precipitation or flocculation by cationic polymer followed by micro-flotation

Objectives:

- Develop a model system and measurement methods to study the destabilization of micro-stickies
- Determine the effect that salts, poly-electrolytes and fibers have on the behavior of micro-stickies

Acrylic Microsphere Adhesive Emulsion: Size Characteristic



Magnification 50X10X0.6

15 μm

Charge Demand Characteristic:

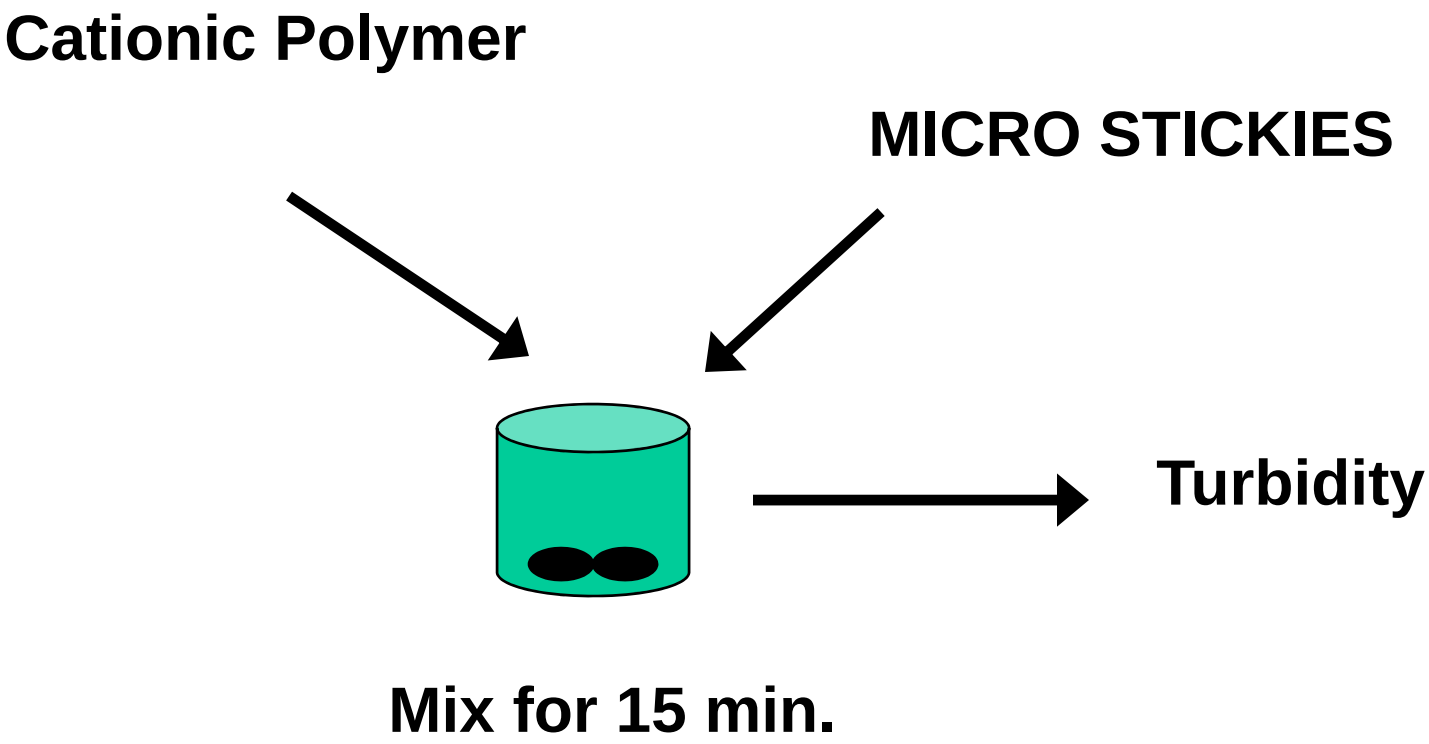
- Micro-sticky -18 μeq/gram
- Fiber -10 μeq/gram
- Cationic Starch +220 μeq/gram

Stability of Model Micro-Stickies

Question:

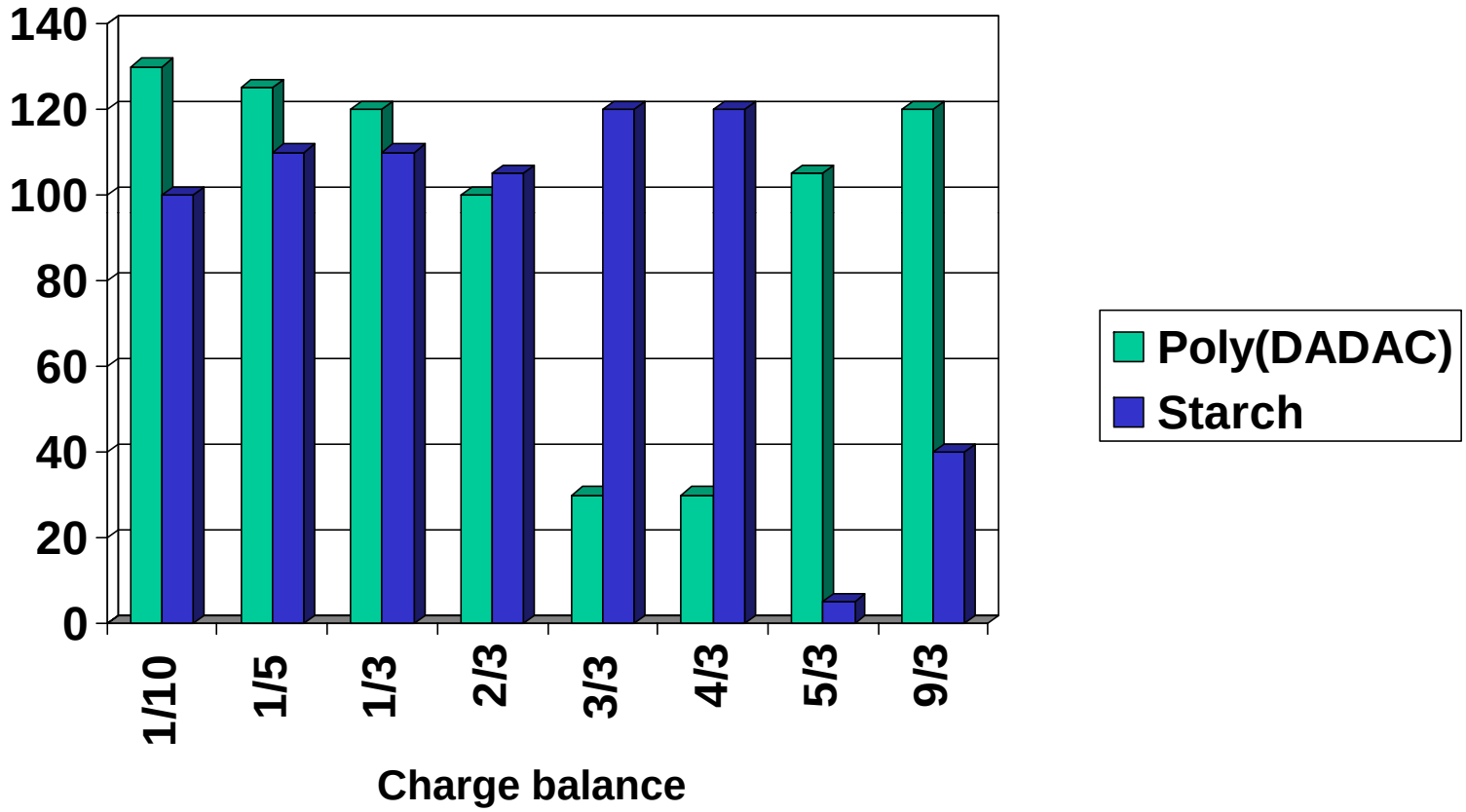
- How will different cationic polymers will affect the stability of the micro-sticky?

Experimental Procedure



Effect of Polymers on Stability of Micro-stickies

Turbidity Overnight (NTU)



Effect of Polymers on Stability of Micro-stickies

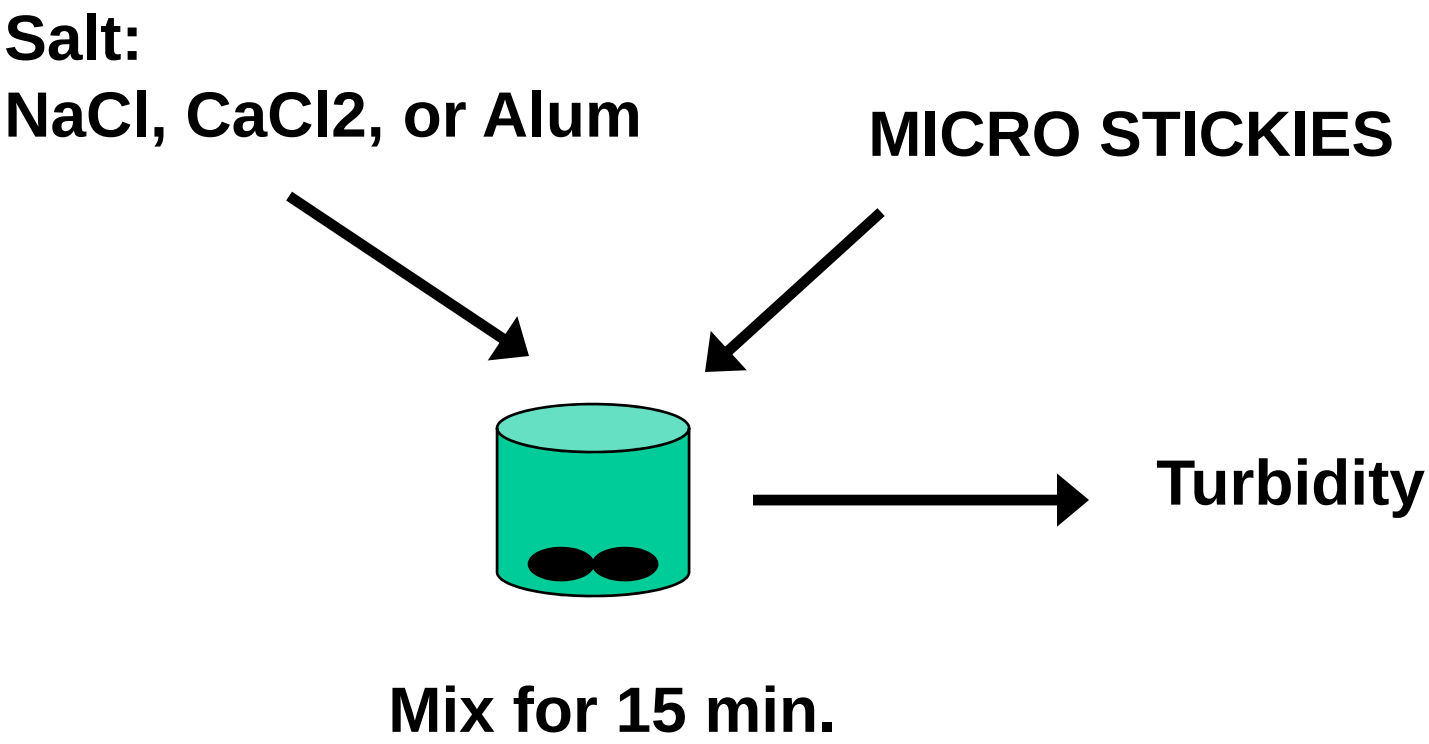
- Poly(DADMAC) was more effective in destabilizing the micro-sticky
- Poly(DADMAC) created strong flocs whereas the starch created weak flocs
- Maximum flocculation for
  - Poly(DADMAC) at neutral point
  - Cationic starch much greater than neutral point
- Steric and charge stabilization for excess amounts of cat material

Stability of Model Micro-Stickies

Question:

- How will salt concentration and valence of counter-ion affect the stability of the micro-sticky?

Experimental Procedure



Critical Coagulation Concentration (CCC)

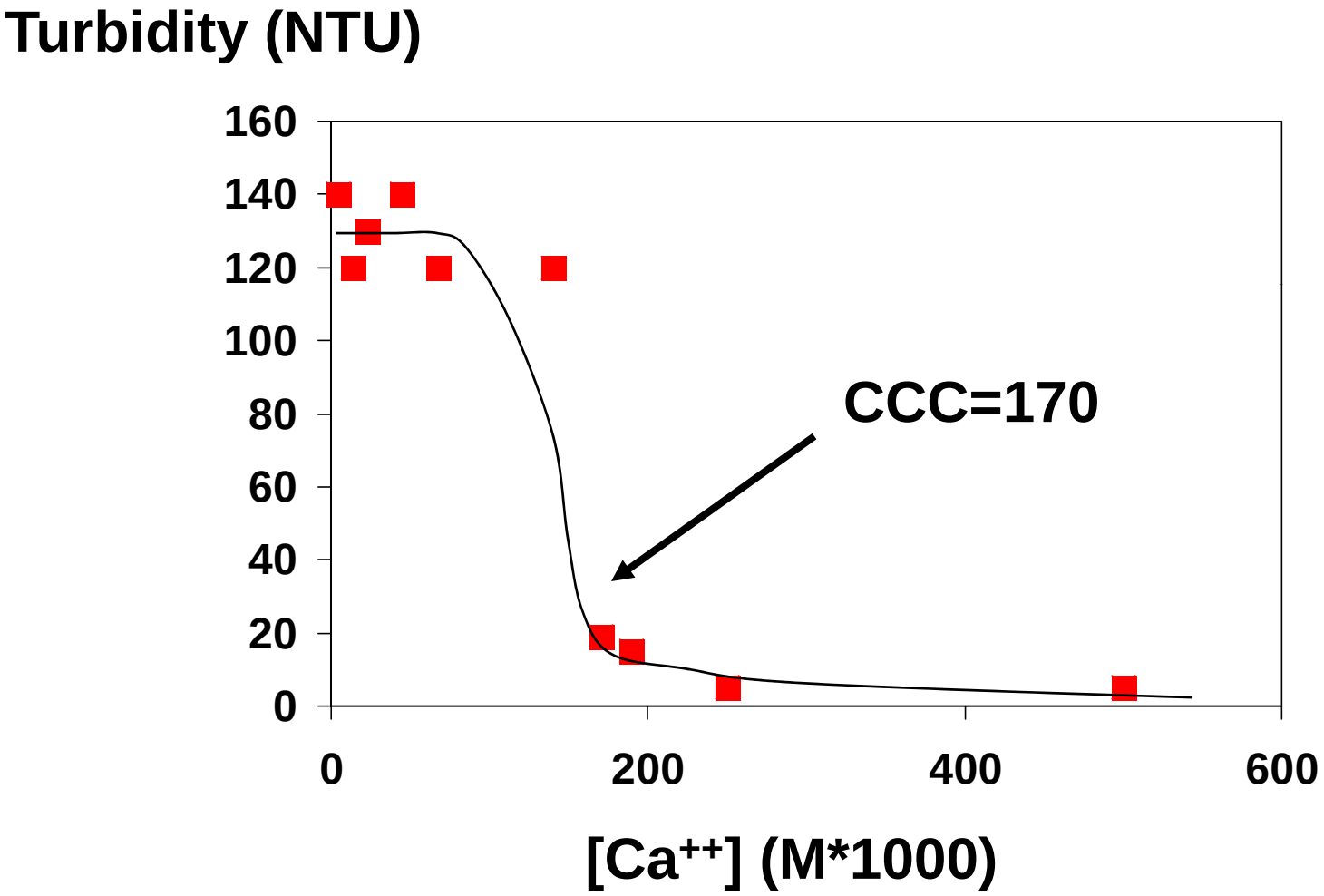
Schultz-Hardy rule

$CCC \propto z^{-6}$

Valency (Z)	CCC
1	1
2	$0.016=1/2^6$
3	$0.0014=1/3^6$

Double-layer thickness depends on counter-ion valency

Effect of Ca^{++} on Micro-Sticky



Effect of Salts on Stability of Micro-Sticky

	CCC	
	Observed	**Expected**
Na^{+}	1.3 M	--
Ca^{++}	1.7E-2	2.0E-2
Al^{+++}	1.3E-3	1.8E-3

Effect of Salts on Stability of Micro-Sticky

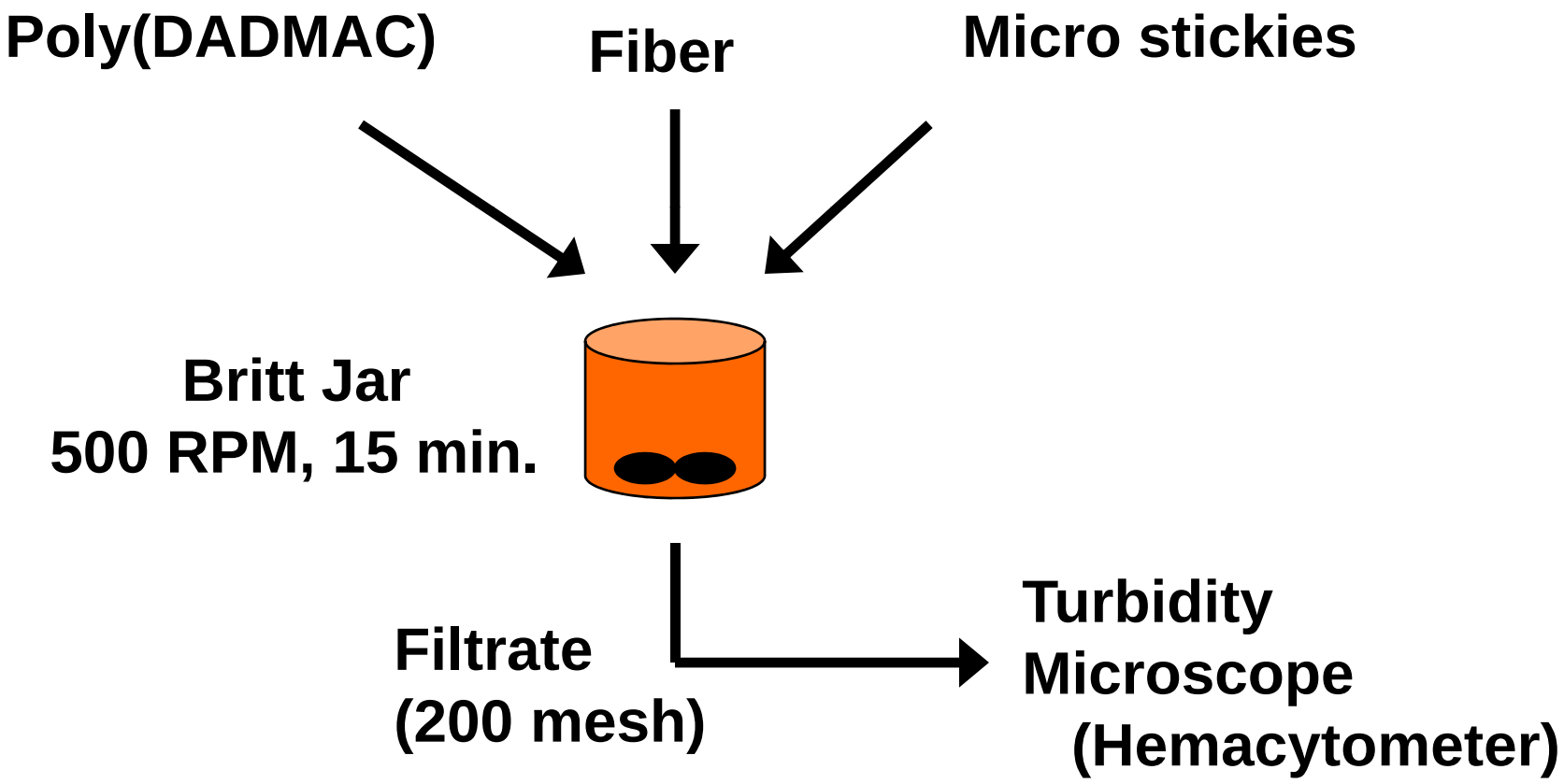
- The coagulation of the micro-sticky closely follows the behavior of the Shultz-Hardy Rule
- Comparison of mill data in the literature to these results indicates:
  - **[Ca^{++}] commonly exists below the CCC**
  - **[Al+++] commonly exists around the CCC**
- MICROSTICKIES BEHAVE AS COLLOIDS WITH AN ELECTROSTATIC DOUBLE LAYER PREVENTING CONTACT

Stability of Model Micro-Stickies

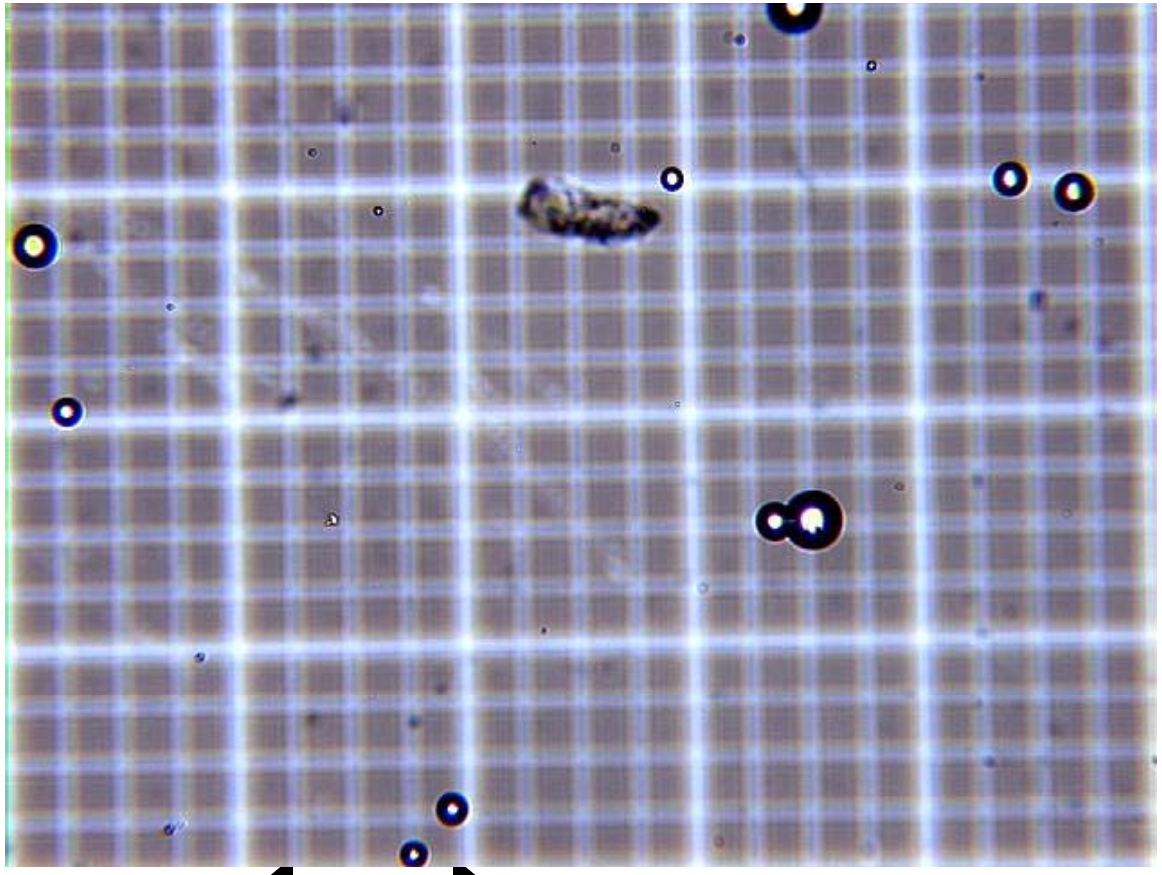
Question:

- How will fibers affect the stability of the micro-sticky in the presence of a cationic polyelectrolyte?

Experimental Procedure

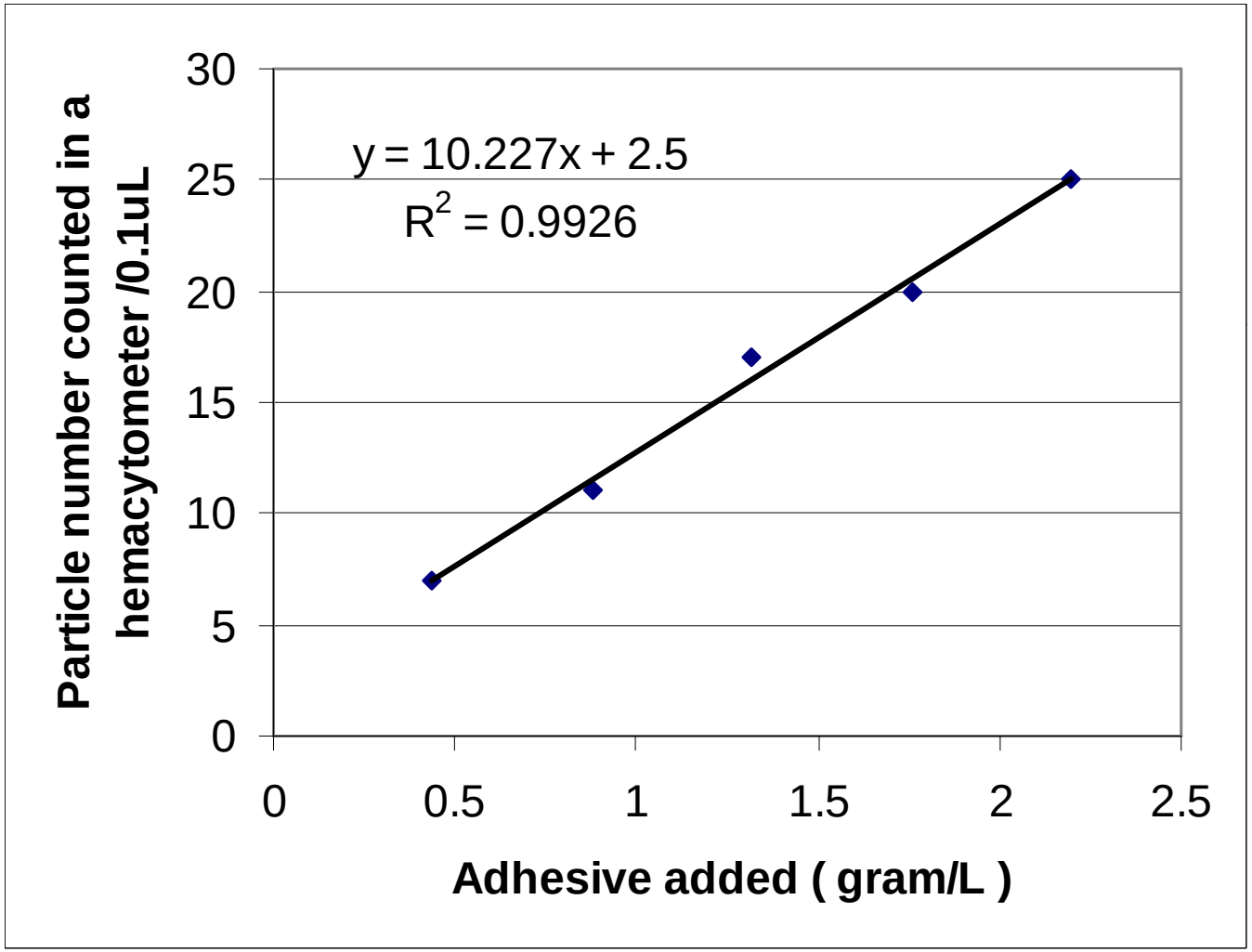


Micro-Sticky Particle Identification with Hemacytometer

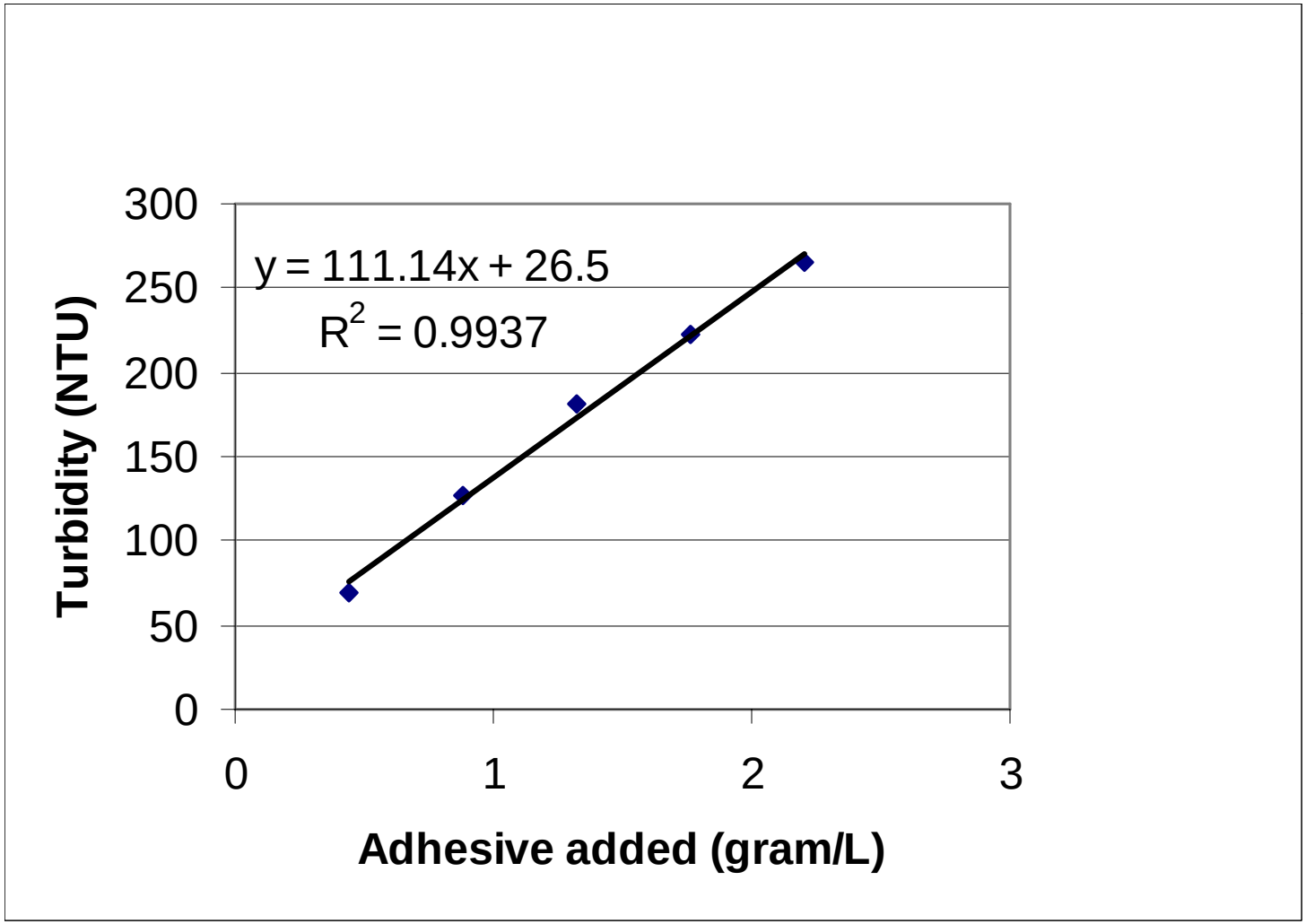


0.2 mm

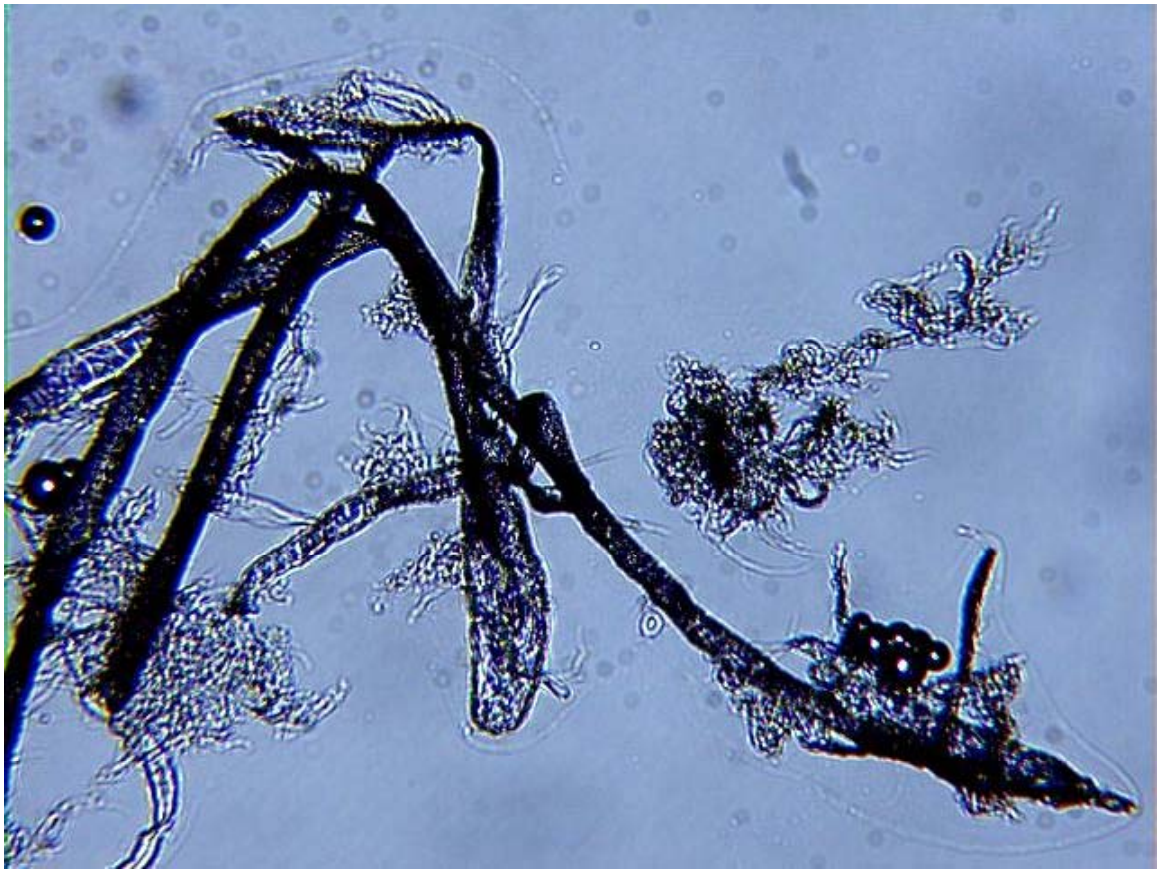
Calibration Line for Hemacytometer



Calibration Line for Turbidity

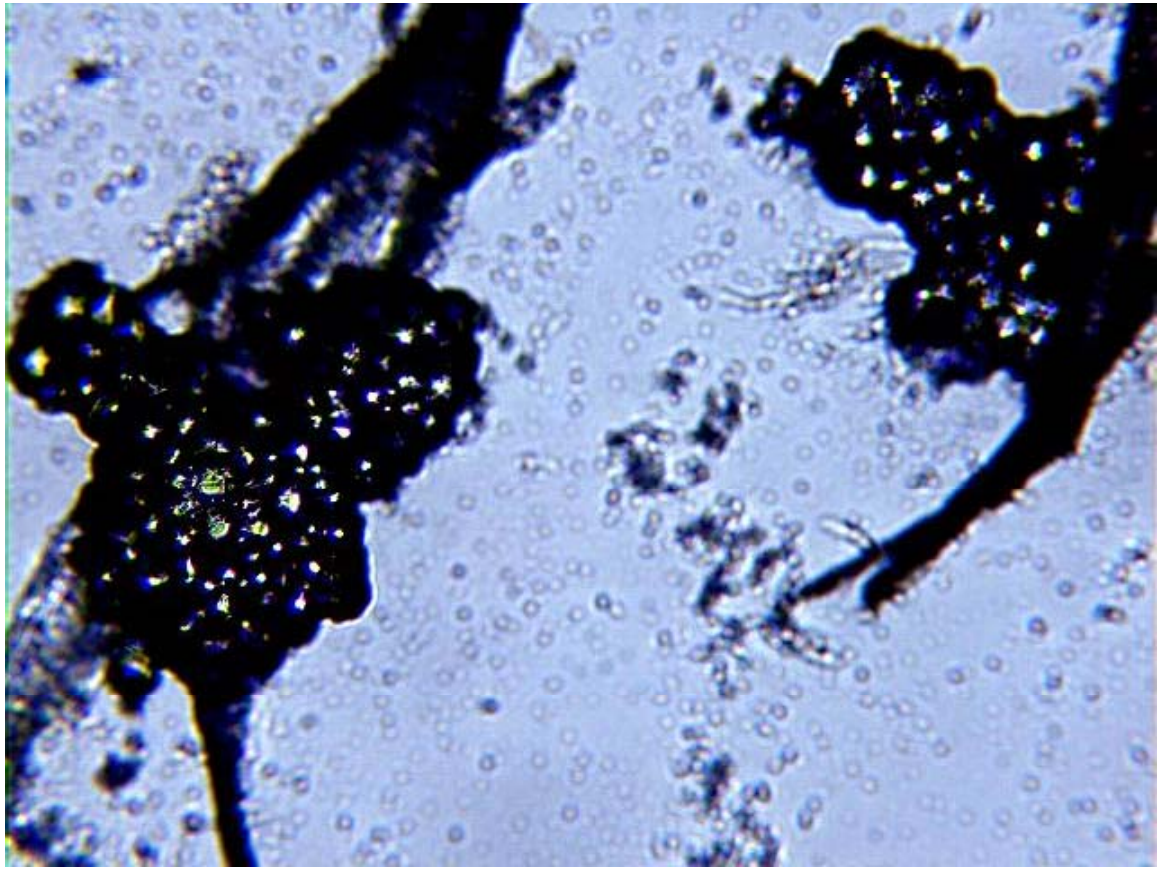


Fibers and Micro-Stickies (No Poly(DADMAC))



Magnification 10X10X0.6

Fibers and Micro-Stickies (with Poly(DADMAC))



Magnification 10X10X0.6

Effect of Fibers on Micro-Stickies in Filtrate

Fiber	Sticky	DADMAC	Turbidity	Count
-	+	-	170	18
+	+	-	136	8
+	+	+(1)	54	0
+	+	+(2)	7	0

(1) to neutralize adhesive only
(2) to neutralize adhesive + fiber

Effect of Fibers on Micro-Stickies

- Fibers compete with the micro-stickies for the poly(DADMAC)
- Micro-stickies flocculate and attach to fibers in the presence of poly(DADMAC)
- Turbidity measurements and the Hemacytometer were useful in tracking the fate of the micro-stickies

Conclusions

- Poly(DADMAC) and cationic starch show optimum points in destabilizing the micro-sticky
- The micro-sticky closely follows the Shultz-Hardy rule for critical coagulation concentration
- The presence of fibers can compete for cationic species with the micro-sticky