Evidential Value of Fiber Evidence

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Responsibilities of the Trace Analyst

- **Get the right answer regarding the comparison – must have ability, use discriminating procedures and follow quality assurance steps**
- **Know your limitations**
- **Determine the significance of the matching evidence - set forth the evidential value**
- **Provide a foundation/basis for the methods used and for your assessment of evidential value**

NAS Report – ISO 17025

Reports must include clear characterization of the limitations of the analyses, including measures of uncertainty in reported results and associated estimated probabilities where possible –

- Title of abstract is incorrect – what I was trying to generate in not the random match probability (in the DNA sense)

- What I am generating is the probability of selecting two carpets from a sample of automobile carpets and finding the fibers in the carpet to forensically match

Evidential Value Based on:

- **Coincidence probability - I believe that the best measure of evidential value is to address the probability of a coincidental match (as in DNA)**

- **Target fiber studies**
- **Population studies**
- **Blocks of color studies**

Pair wise comparisons of samples (can be used to evaluate comparison method as well as to examine variation in characteristics in a sample)

From Mike Grieve – Sufficient studies have now been made to allow some important general conclusions to be drawn from them

- **The chance of finding a particular color/type combination among a random population of foreign fibers is very low**
- **The chance of a collective of these fibers being present is even lower especially if synthetic fibers are involved.**
- **The occurrence of a group of fibers on a surface that match those from a particular textile source constitutes strong evidence of contact with that source**
- **The chance of finding differences between potentially matching target fibers recovered from a particular surface will increase proportionately to the number of comparative tests used to exam them (up to a point)**

Evaluating Associative Forensic Science Evidence – Barry Gaudette

Fundamental questions:

1. **What is the probability that the association was due to coincidence?**
2. **What is the probability that the association was due to examiner error?**
3. **What is the probability that there is an alternative explanation for the evidence such as secondary transfer, contamination or deliberate planting?**

Project design

- 200 carpet samples collected after 200 vehicles selected at random from a 2000 vehicle junkyard in Northern Virginia in 2008
- Purpose - to conduct pairwise comparisons of all collected samples. How many associations are there? Can a meaningful coincidence probability be obtained
- Most vehicles in junk yard late model (1993-2005)
- 200 samples – each compared with each other gives 19900 comparisons – need a database
- Comparison microscope not very useful
- Attempt to set up database to reduce actual comparisons
- Spectrophotometry eventually run on each sample.

CROWN VICTORIA	2004	DFS50238
CIVIC	2001	DFS50248
VOLVO 70 SERIES	1998	DFS50380
ACCORD	1996	DFS50400
JETTA	1996	DFS50401
NEON	2001	DFS50402
MAZDA MILLENIA	1996	DFS50403
VOLVO 70 SERIES	1998	DFS50404
ALTIMA	1996	DFS50405
LEXUS ES300	1993	DFS50407
AVALON	1996	DFS50408
SILHOUETTE	1999	DFS50409
SEBRING	1996	DFS50410
INTRIGUE	1999	DFS50411
SATURN S SERIES	1999	DFS50412
CAVALIER	2003	DFS50413
ACCORD	1998	DFS50414
VOYAGER	1997	DFS50415
ASTRO	1997	DFS50416
INFINITI J30	1994	DFS50417
SABLE	2000	DFS50418
TAURUS	1997	DFS50419
LUMINA CAR	1996	DFS50421
COROLLA	2000	DFS50422
INTRIGUE	1998	DFS50423
CAMRY	1995	DFS50424
LINCOLN LS	2000	DFS50425
ALTIMA	1998	DFS50427
CAPRICE	1995	DFS50437
WINDSTAR	2002	DFS50462
LHS	1995	DFS50468
PARK AVENUE	1996	DFS50469
GRAND MARQUIS	1996	DFS50471
MAZDA 626	1999	DFS50472
TAURUS	1993	DFS50473
TAURUS	1999	DFS50474
VOYAGER	1996	DFS50475
GRAND AM	1994	DFS50476
ESCORT	1995	DFS50477
STEALTH	1993	DFS50478
CONTOUR	1998	DFS50479
STRATUS	1999	DFS50480
PARK AVENUE	1994	DFS50481
ELDORADO	1995	DFS50482
JETTA	2001	DFS50483
VOLVO 740	1992	DFS50487
SONATA	1997	DFS50488
ALERO	1999	DFS50489
DEVILLE	2000	DFS50495
CUTLASS	1997	DFS50502
SATURN S SERIES	1996	DFS50504
GALANT	1999	DFS50507

		Model	Manufacturer	year	Greenleaf #	VIN #	Vehicle Color	Carpet Color	Location of cutting
1	31	LHS		1995	DFS50468				
2	53	GALANT		1995	DFS50511				
3	56	ACCORD		1998	DFS50526				
4	76	CIVIC		1993	DFS50585				
5	136	MALIBU		2000	DFS50721				
6	138	EXPEDITION		1997	DFS50723				
7	148	PRIZM		2001	DFS50735				
8	150	MALIBU		1998	DFS50737				
9	154	MAZDA 626		2000	DFS50741				
10	158	CAVALIER		1998	DFS50747				
11	170	WINDSTAR		2002	DFS50760				
12	171	FORD VAN		2001	DFS50761				
13	185	COROLLA		1996	DFS50786				
14	186	TL		2001	DFS50787				
15	199	SAFARI (GMC)		1999	DFS50802				
16	207	SABLE		1999	DFS50817				
17	227	GRAND CHEROKEE		2001	DFS50842				
18	232	ENVOY		1998	DFS50850				
19	236	DODGE 1500 PICKUP		1998	DFS50857				
20	238	FOCUS		2002	DFS50860				
21	246	CHEVROLET VAN		1998	DFS50868				
22	297	CONTOUR		1996	DFS60032				
23	303	TAURUS		1998	DFS60039				
24	312	DURANGO		1998	DFS60048				
25	316	COUGAR		2001	DFS60052				
26	320	STRATUS		2000	DFS60056				
27	325	BEETLE		1999	DFS60061				
28	332	CAMRY		1995	DFS60069				
29	339	LUMINA CAR		1995	DFS60076				
30	358	EXPLORER		2000	DFS60099				
31	363	CONTOUR		1999	DFS60104				
32	367	BMW 318i		1997	DFS60108				
33	376	SEBRING		1997	DFS60118				
34	385	GRAND AM		1997	DFS60128				
35	395	PRELUDE		1998	DFS60138				
36	402	LUMINA CAR		1997	DFS60145				
37	417	DEVILLE		1996	DFS60161				
38	422	WINDSTAR		2000	DFS60166				
39	424	CIVIC		2000	DFS60168				
40	433	STRATUS		1999	DFS60180				
41	438	MUSTANG		2001	DFS60185				
42	453	ECLIPSE		1999	DFS60203				

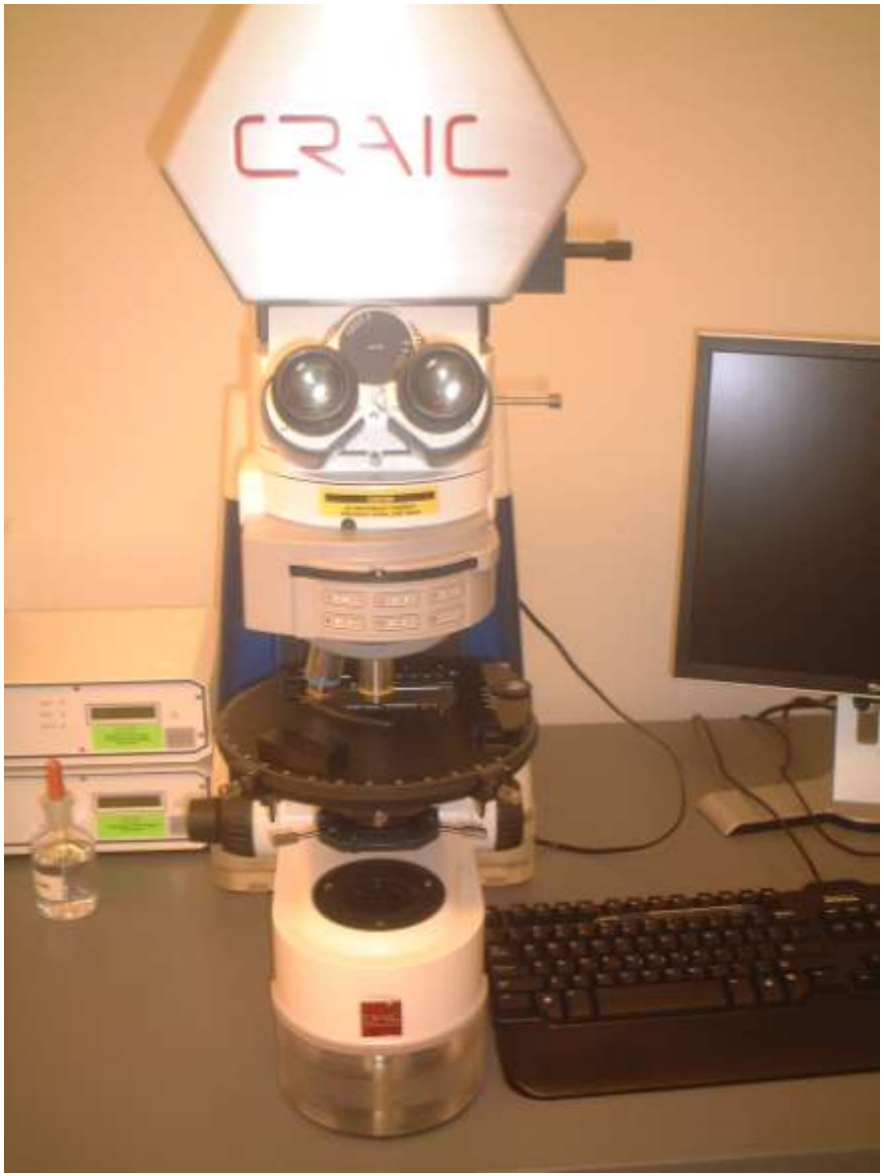
Sample characteristics

- 89.5% nylon
- 10% polyester
- .5% polypropylene

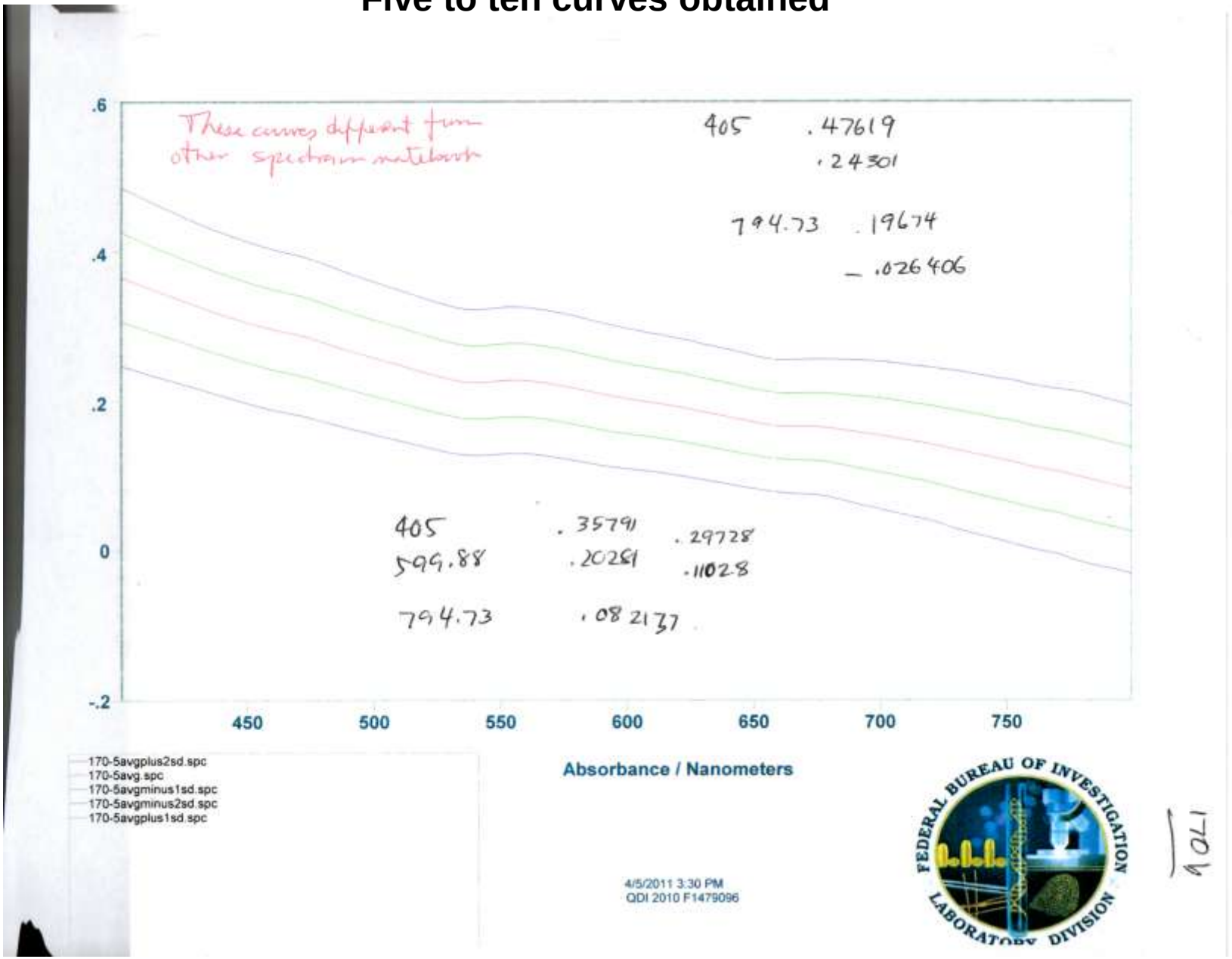
  – 91% trilobal (various shapes), 9% round

  But most individual fibers have very little dye

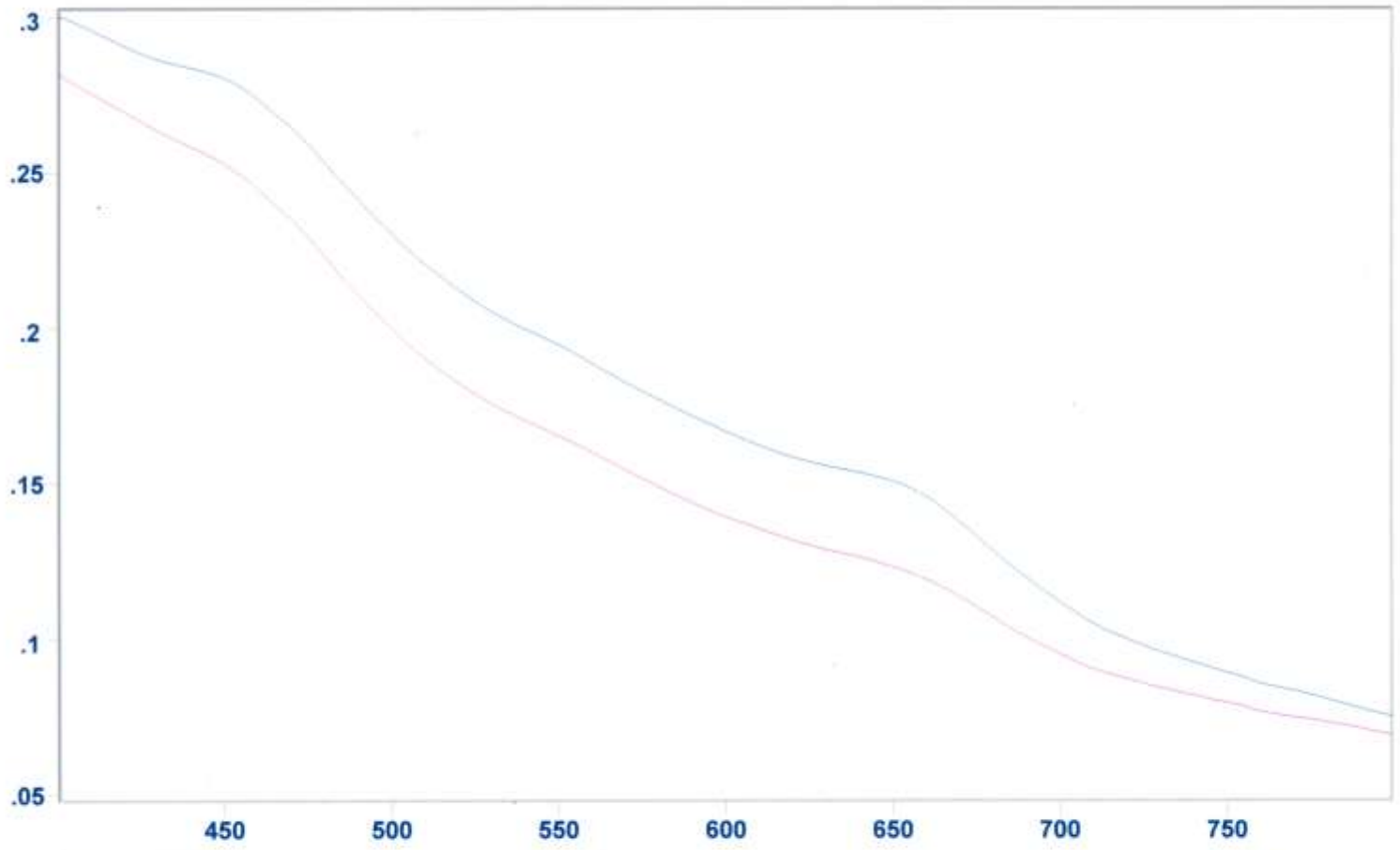
CRAIC microspectrophotometer



Five to ten curves obtained



		A 405			A600		A795	
fiber #		2sd	aver	2sd	aver	2sd	aver	2sd
11a	15-Apr	0.731	0.560	0.389	0.387	0.226	0.168	0.105
11b	10-Jun	0.786	0.525	0.267	0.234	0.011	0.023	-0.068
		(0.055)	**0.035**	**0.122**	**0.153**	**0.215**	**0.144**	**0.174**
19	10-Dec	0.350	0.090	-0.168	0.012	0.188	-0.053	-0.286
19a	10-Jun	0.246	0.065	-0.122	-0.065	0.027	-0.138	-0.301
		0.104	**0.025**	**(0.046)**	**0.077**	**0.161**	**0.085**	**0.015**
20a	21-Dec	0.626	0.531	0.440	0.243	0.091	0.038	-0.007
20b	10-Jun	0.571	0.450	0.335	0.243	0.080	-0.018	-0.121
		0.056	**0.081**	**0.105**	**(0.000)**	**0.011**	**0.056**	**0.114**
23	15-Apr	0.670	0.523	0.378	0.324	0.331	0.161	0.007
23a	3-Jun	0.731	0.586	0.443	0.423	0.312	0.184	0.055
23b	10-Jun	0.513	0.359	0.201	0.146	0.194	-0.012	-0.227
		0.218	**0.227**	**0.242**	**0.277**	**0.137**	**0.196**	**0.282**
24	6-Jan	0.687	0.545	0.407	0.331	0.225	0.331	0.010
24a	10-Jun	0.656	0.468	0.283	0.211	0.014	-0.016	-0.038
		0.030	**0.077**	**0.124**	**0.120**	**0.211**	**0.346**	**0.048**
31	13-Dec	2.066	1.681	1.320	1.553	1.580	1.054	0.793
31a	15-Feb	1.797	1.677	1.552	1.556	1.279	1.048	0.820
		0.269	**0.004**	**(0.232)**	**(0.003)**	**0.301**	**0.006**	**(0.028)**
32	13-Dec	0.983	0.898	0.877	0.346	0.228	0.105	-0.156
32a	4-Jan	1.107	0.895	0.681	0.339	0.164	0.104	0.047
		(0.124)	**0.003**	**0.196**	**0.007**	**0.064**	**0.001**	**(0.203)**
33	13-Feb	0.712	0.595	0.523	0.436	-0.415	0.025	-0.157
33a	4-Jan	0.682	0.596	0.510	0.433	0.036	0.023	0.008
		0.030	**(0.001)**	**0.013**	**0.003**	**(0.451)**	**0.002**	**(0.165)**
60	6-Jan	0.271	0.199	0.132	0.097	0.046	0.022	0.007
60a	13-Jan	0.266	0.181	0.090	0.106	0.037	0.018	0.001
		0.006	**0.018**	**0.042**	**(0.009)**	**0.009**	**0.004**	**0.006**
61	6-Jan	0.676	0.562	0.451	0.272	0.174	0.141	0.107
61a	13-Jan	0.576	0.481	0.383	0.229	0.135	0.100	0.069



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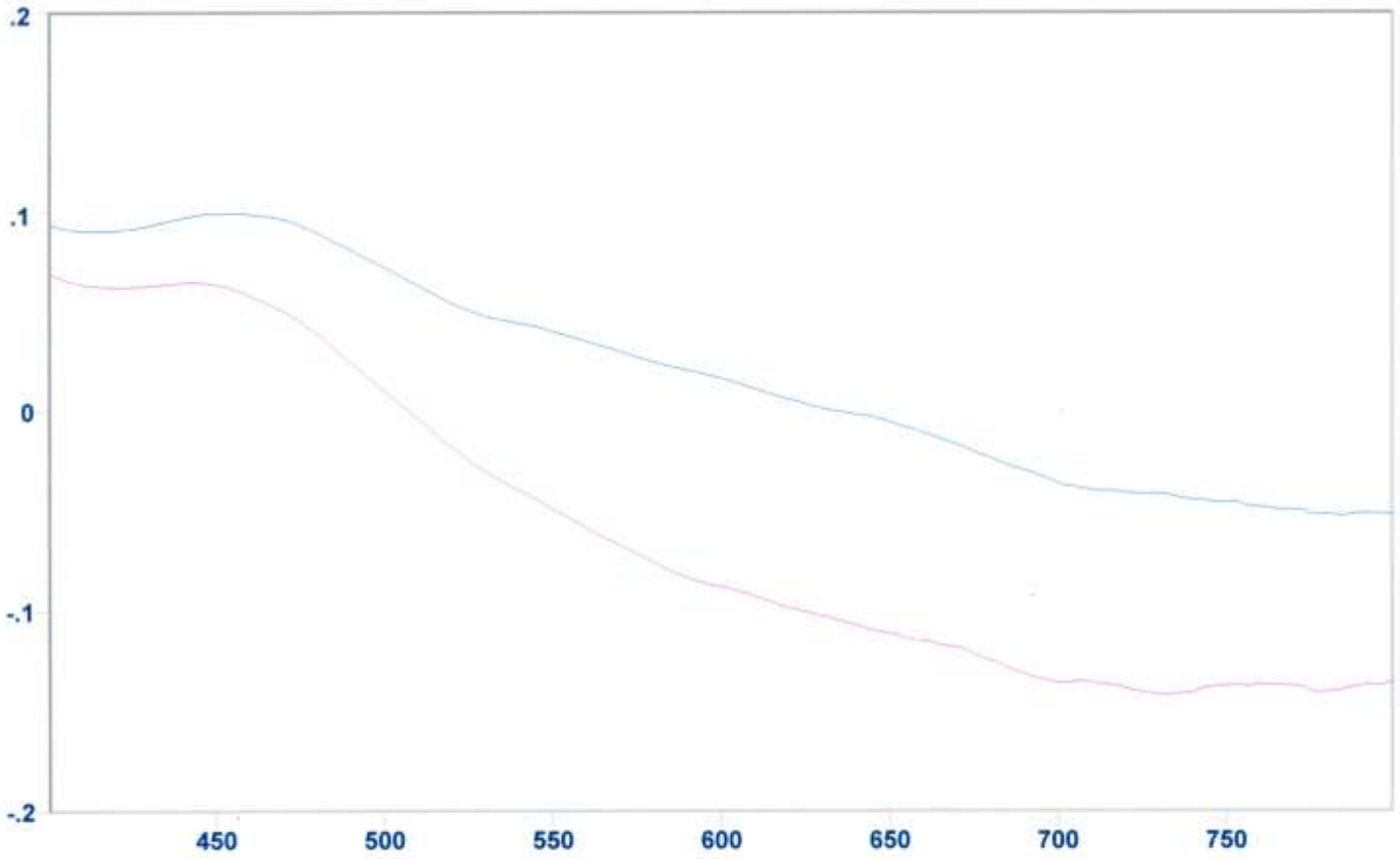

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Data base - Filemaker Pro

- Tried to avoid subjective assessments – but subjectivity will always be present
- Tried to avoid bias but also an issue
  - Any association I determine to exist reduces the significance of an association based on fiber evidence

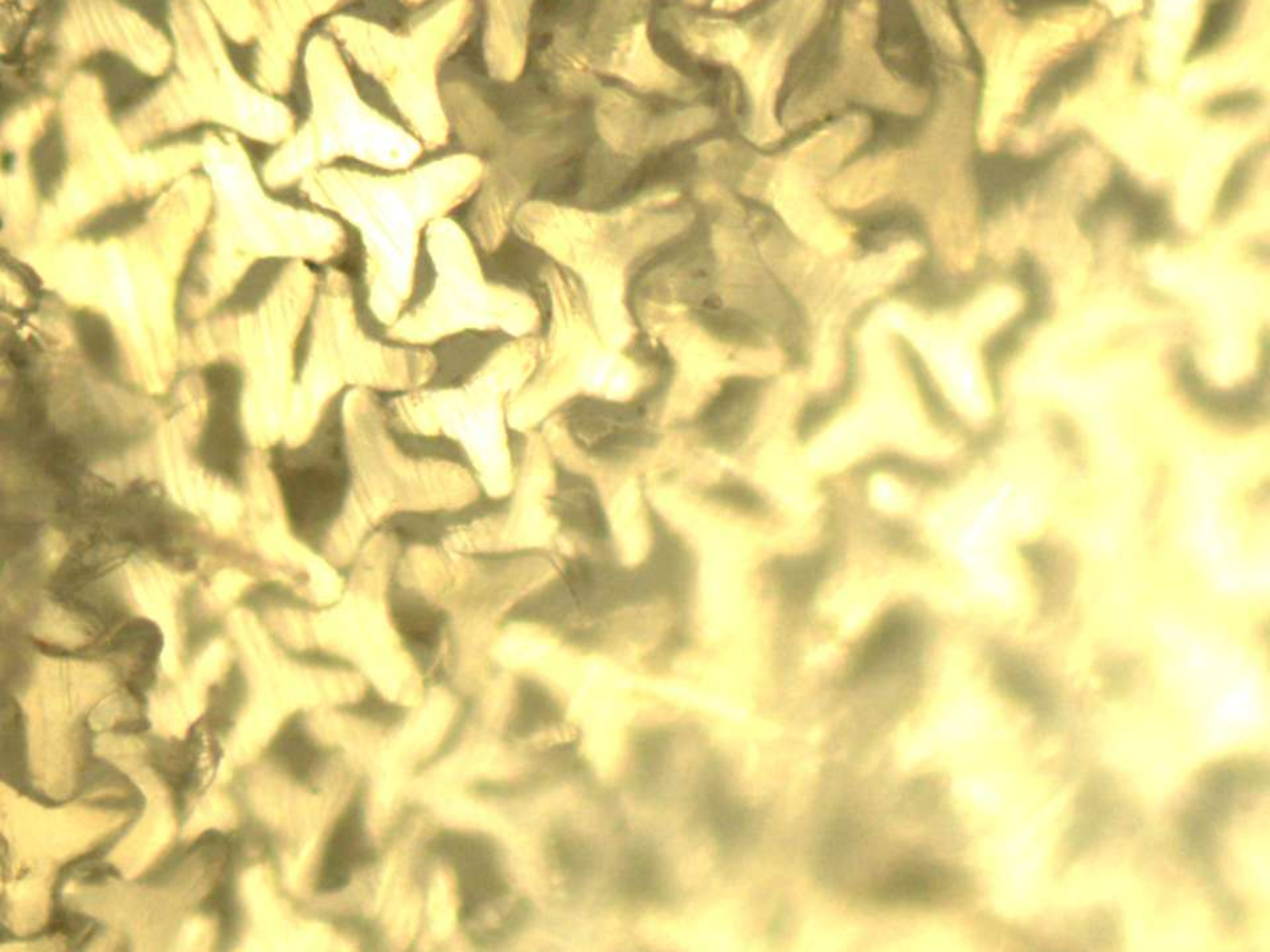
Database classes

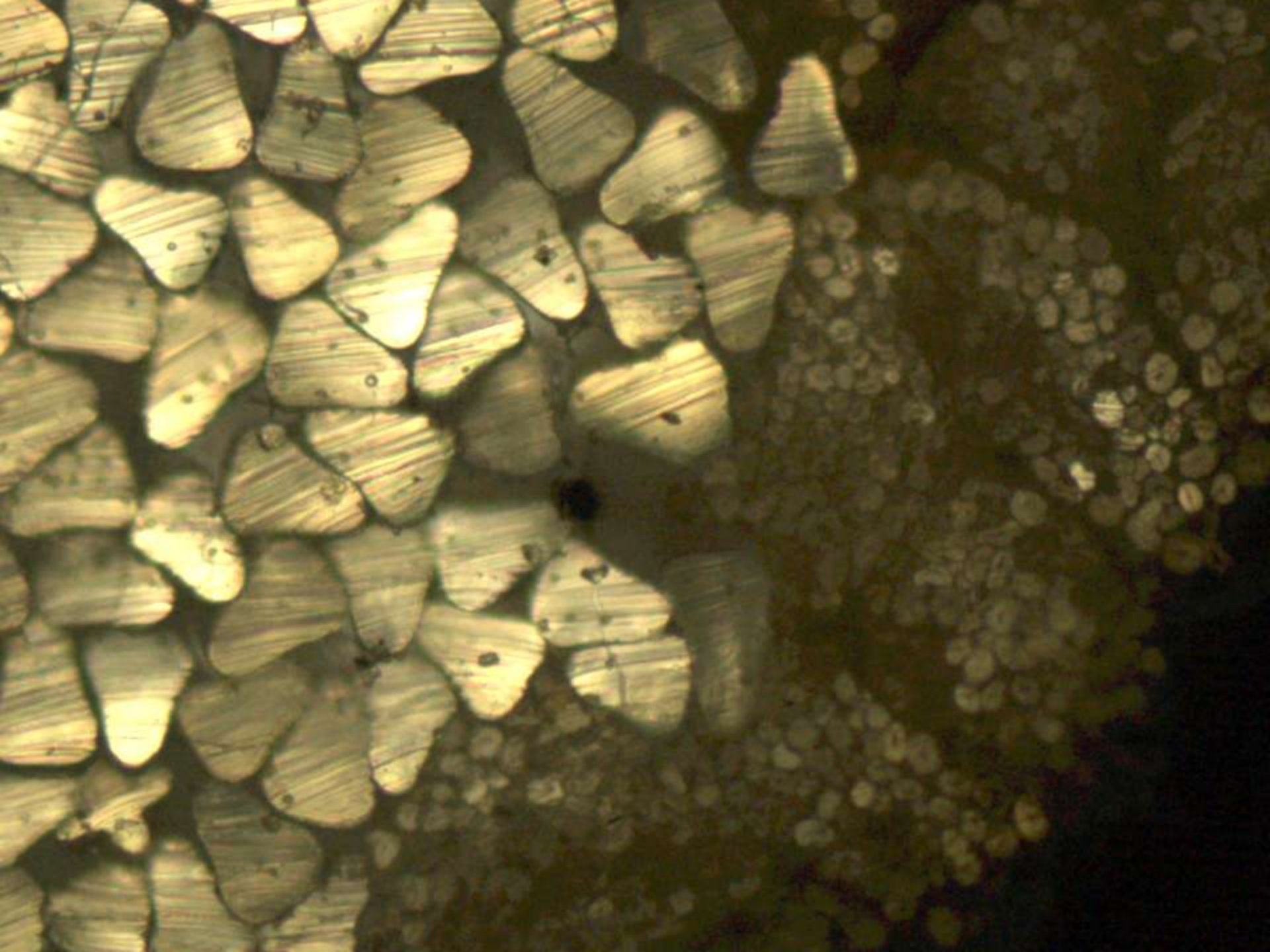
Color – gray, brown, colorless, other

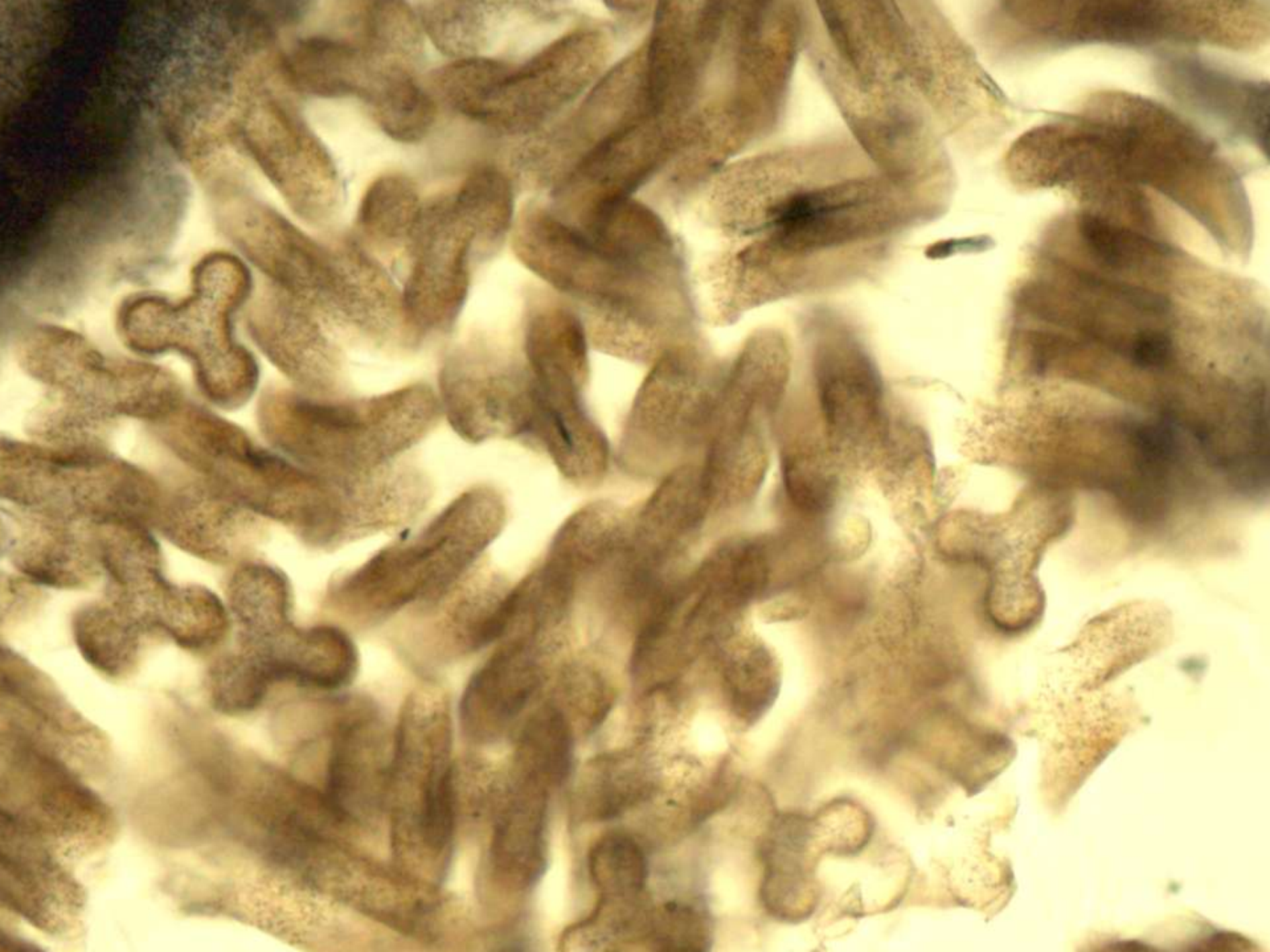
Cross section – regular, irregular, round and Michelin Man

Delusterant – yes, no

Is there a good way to included absorbance info into database?







Actual matches

20/19900 = .001005

Probability of a coincidental match is approximately

1/1000 (conservative estimate)

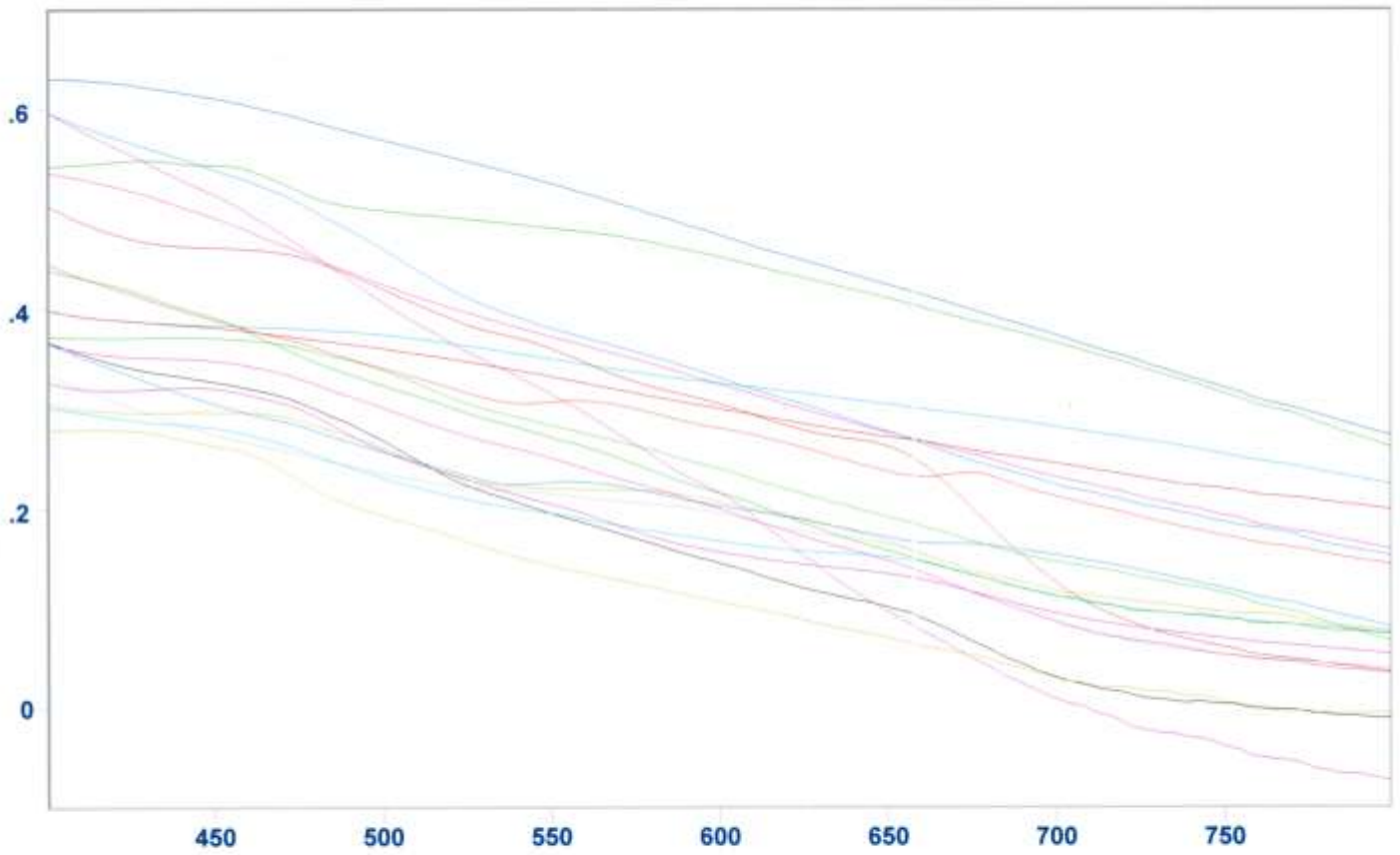
Base on microscopy and spectrophotometry

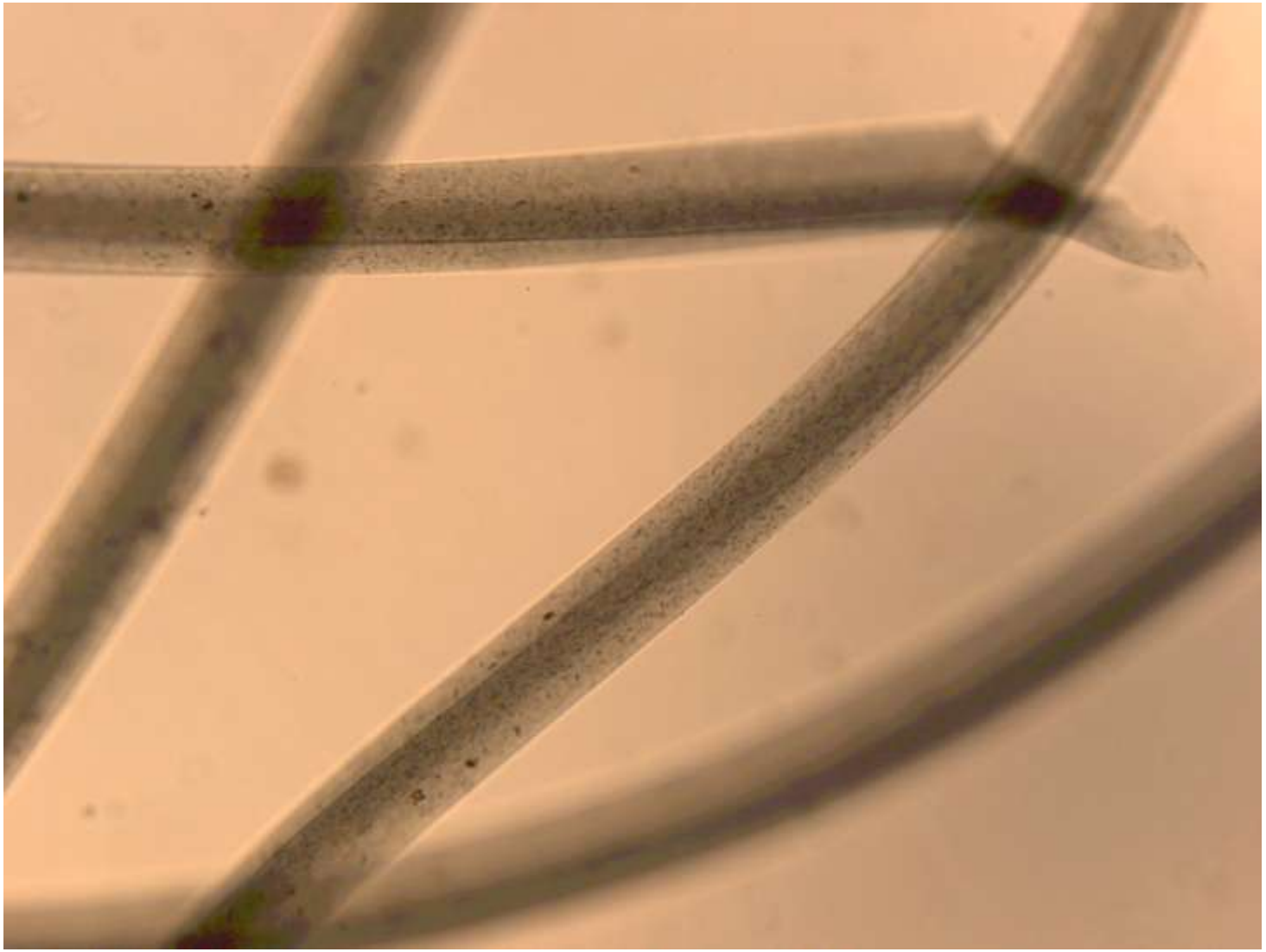
Problems encountered

- **Not much color**
  - **Most samples some shade of gray or brown**
    - **Only 3 samples had a color like red or green**
    - **Comparison scope not very helpful**
  - **Many single fibers showed little if any color (even if carpet had obvious color)**
  - **Need spectrophotometry to conduct meaningful comparisons (a large number of lightly dyed fibers have the same cross section shape**
  - **Most samples were nylon – FTIR not used and probably not very helpful (could add some discrimination and would be used in a typical fiber case).**
  - **Considerable variation in absorption curves from different fibers in the sample**

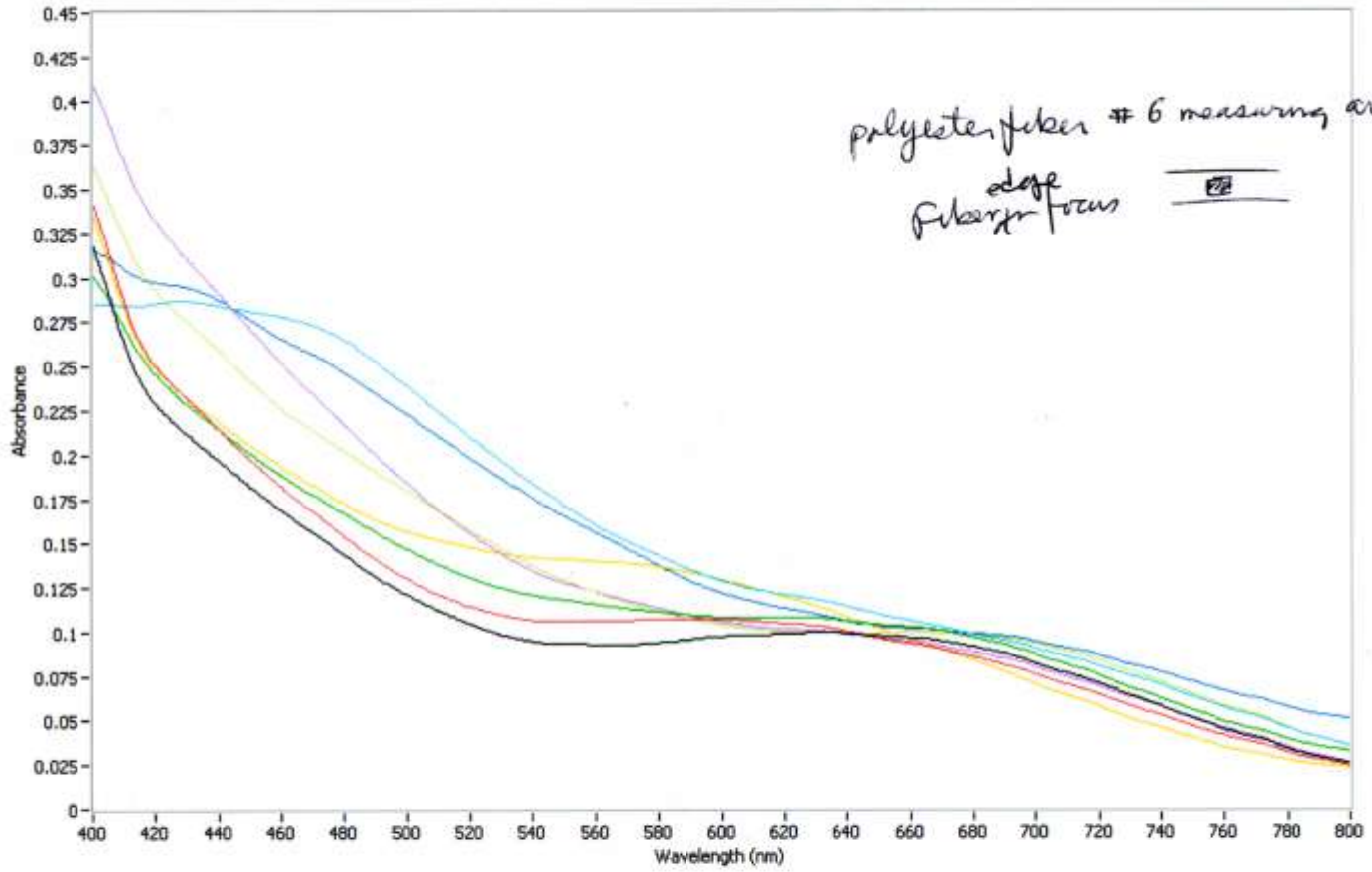

Colorless Michelin Man – 32 samples

Colorless nylon regular trilobal delustered





polyester test 2



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polyester test

Forensic Science Errors

Root cause is bias – **systematic distortion**

The forensic process of investigation and trial almost inexorably tilts and warps the underlying science

Two types of bias

- An inherent bias towards producing a positive outcome or results
- A tendency in an adversarial system of investigation and trial to lead to partisan behavior

Microscopes and Attachments
Fiber Analysis Protocol

- **Stereo binocular microscope**
- **Comparison microscope**
- **Polarized light microscope**
- **Fluorescence microscope**
- **Microspectrophotometer**
- **Fourier transform infrared spectrometer**

Future work

- Which vehicles have matching fibers
- Additional comparison procedures
- Other procedures for conducting database comparisons
- Cross sections (more accurate classification)
- FTIR (meaningful added discrimination?)
- UV microspectroscopy
- First derivative analysis

Last two procedures not typically used in US – might be useful with lightly dyed fibers