Condition Monitoring of Microfibre Cloths Within Healthcare Environments

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CONTENTS

1. INTRODUCTION

This report documents the work carried out investigating the condition of microfibres exposed to differing disinfection wash processes involving temperature and ozone, under both laboratory and site conditions.

Microfibres are generally a blend of polyester and polyamide, which have undergone a process splitting the yarn into thousands of tiny fibres. This creates a structure with a vast surface area capable of working effectively in both dry (fig 1) and wet (fig 2) conditions[1].

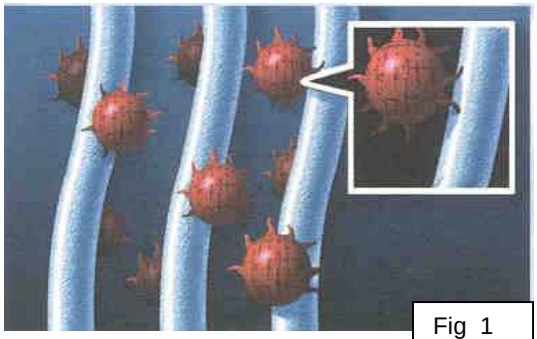

Fig 1

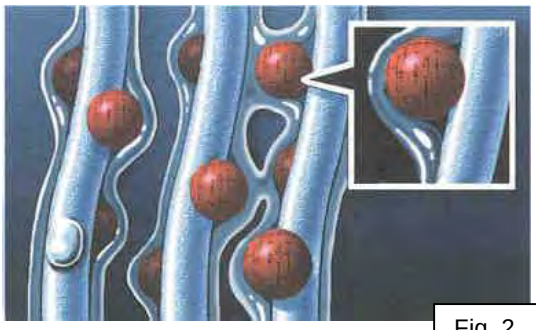

Fig 2

The use of microfibre technology within the healthcare environment has been well documented in providing improvements in hygiene standards. Various health authorities, cleaning contractors and microfibre suppliers both in the UK and Europe, have carried out studies. Throughout the studies an over-riding factor influencing the use and performance of these cloths is the need for an effective and daily laundry service. The volume of cloths can be huge which means a dedicated resource is needed. Without the provision of a good laundry facility, this system is of no value[1].

Current hospital guidelines governing the laundering process utilise wet heat as a method of disinfection. This does not always provide sufficient disinfection, however, particularly in terms of spore forming bacteria. In addition the system is also totally reliant on the operator selecting the correct program and the specified temperature being maintained for the given contact time.

OTEX, a pioneering laundry system utilising ozone and developed by JLA, has been introduced into a range of healthcare establishments. It has been used successfully for washing healthcare laundry including microfibres in both nursing homes and hospitals for over four years. Results from independent microbiologists have demonstrated the disinfectant properties of ozone employed within the laundering process is effective in dealing with high challenges of bacteria and viruses, including MRSA and spore forming bacterium such as Clostridium difficile. In addition the wash process benefits from the use of low temperatures to achieve disinfection, resulting in considerable utility savings in terms of hot water and electricity.

2. BRIEF DESCRIPTION OF WORK CARRIED OUT

New microfibre cloths together with samples of used cloths from a variety of "live" laundry sources (i.e. from hospital and nursing homes utilising either traditional thermal or OTEX washing processes) were tested.

The cloths were subjected to a number of physical tests. This included an investigation in response to issues raised by one of the microfibre suppliers into the relationship between condition and degree of colour loss on microfibres. Further physical testing to assess performance concentrating on absorbency and loss in surface area, i.e. shrinkage, was considered necessary to provide corroborative data. In addition electron microscope imaging took place on the materials by an independent laboratory Scientifics Ltd, to provide both photographic evidence and expert opinion on the condition of the materials.

3. CHEMICAL RESISTANCE

The environment and the methodology in which these cloths are used (i.e. no additional chemicals used for surface cleaning) emphasises the need to maintain condition and integrity of the microfibre throughout its service life. In addition the use of colour coding on cloths and mops is widely used to help prevent cross contamination by the transfer of bacteria when cleaning different surfaces and areas. It is therefore equally important to maintain a degree of colour during the life of these items.

Colour loss will occur over a period of time, however, irrespective of the wash process adopted. Exposure to chemicals such as hypochlorite or sodium dichloroisocyanurate either through use or misuse will also affect the extent of colour loss. The microfibre cloths are generally produced from a blend of 80% polyester and 20% polyamide fibres, as a narrow fabric with over locking to both ends and "fabric " dyed. The dye's susceptibility to fade will depend upon the particular dye process used. Certain dyes are more susceptible to fading from chemicals and differing pH conditions. Many dyes, especially blues, are prone to ozone fading. Some disperse dyes used with nylon, especially blues; exhibit the tendency of ozone fading[2]. One of the manufacturer's of the cloths advises that colour may run if coloured cloths/mops are washed together with uncoloured ones and but states that discoloration will ***not*** affect the cleaning characteristic of the material.[3]

Both polyester and polyamides have good chemical resistance. In particular polyester can withstand a range of chemicals including oxidising agents and is normally only affected by strong alkalis. In strong alkaline solutions, such as sodium hydroxide, polyester fibre can be broken. Its outer layer is peeled away. The rate of peeling increases with increasing alkalinity and increasing water temperature over 40^{o}C. If a cationic disinfectant, such as a quaternary ammonium compound (QAC), is added to the alkaline solution, a catalytic breakdown of the polyester material will take place, causing it to quickly lose its strength[2]. Polyamides tend to be more susceptible to acids but can also be weakened by strong alkalis.

Manufacturers of the microfibres recommend that chemicals are not used with microfibres for surface cleaning. During the low temperature ozone wash process a neutral pH is maintained throughout the whole cycle. No hot water is used within the wash cycle.

4. LABORATORY TESTS

All microfibres assessed in this project were either from the Jonmaster range supplied by Johnson Diversey or supplied by EcoLab.

4.1 Laboratory Controlled Exposure Test

Microfibre cloths were exposed to high levels of ozone gas(>10ppm) and ozone dissolved in water (>1ppm). These concentrations were far in excess of any concentration likely to be encountered during normal laundering processes. The results were as expected with excessive fading, particularly on the sample exposed to ozone gas. Samples were then submitted together with a new cloth for comparative purposes to Scientifics Ltd. This would provide an independent assessment to determine if there was any relationship between colour loss and microfibre condition.

Scientifics Ltd Microscopic Examination of Microfibre Cloths: ***Photographs given below show microfibres still in good condition following exposure to both ozone gas and immersion in ozonated water.***

Photo 1: New cloth exhibiting regular flat fibres.
Batch No: 010.754

Photo 2: Ozonated water treated cloth exhibiting regular flat fibres.
Batch No: 010:0754

Photo 3: Gaseous ozone treated cloth exhibiting regular flat fibres
Batch No: 010:0754

4.2 Laboratory Controlled Wash Test

Cumulative wash programs were run under extreme conditions, i.e. high concentrations of ozone, with/without tumble-drying, and no detergent. The objective being to establish the degree of colour loss under extreme conditions. Samples were subsequently forwarded to an independent laboratory Scientifics Ltd for electron microscope imaging to ascertain whether any chemical damage had occurred. The results are as follows:

Table 1: Laboratory controlled colour fading test results.

Number of Cycles	***% Colour Loss (Jonmaster Microfibre Batch No: 010:754)***		
	OTEX Wash Only 4g/hr output	**OTEX Wash @ 4g/hr & Tumble Dried at 180F**	***Thermal Disinfection @ 75C & Tumble Dried at* 180F**
100	50	66	<10

Table 2: Scientifics Ltd Microscopic Examination of Microfibre Cloths

Description	**Gross appearance**	**Fibre appearance**
OTEX Wash Only 4g/hr output	Fibres still in discernible loops, however visibly looser	Ribbon like fibres, very little damage/twisting noted
OTEX Wash @ 4g/hr & Tumble Dried at 180F	Tight loops of fibres, still regularly arranged visibly in rows	Majority of fibres show some twisting, although minimal, remainder are smooth and ribbon like
***100 Thermal Disinfection @ 75C & Tumble Dried at* 180F**	Tight loops of fibres, still regularly arranged visibly in rows	Majority of fibres show some twisting, although minimal, remainder are smooth and ribbon like with occasional small knotted sections
Scientifics Ltd Conclusion: "*The visual examination of these samples showed no evidence of systematic chemical damage to the structure of the cloths or to the individual fibres. The damage that was noted is entirely more consistent with physical 'wear and tear', that is to say the twisting of individual fibres and general stretching of the loops of arranged fibres."*		

Photo 4: New, untreated microfibre

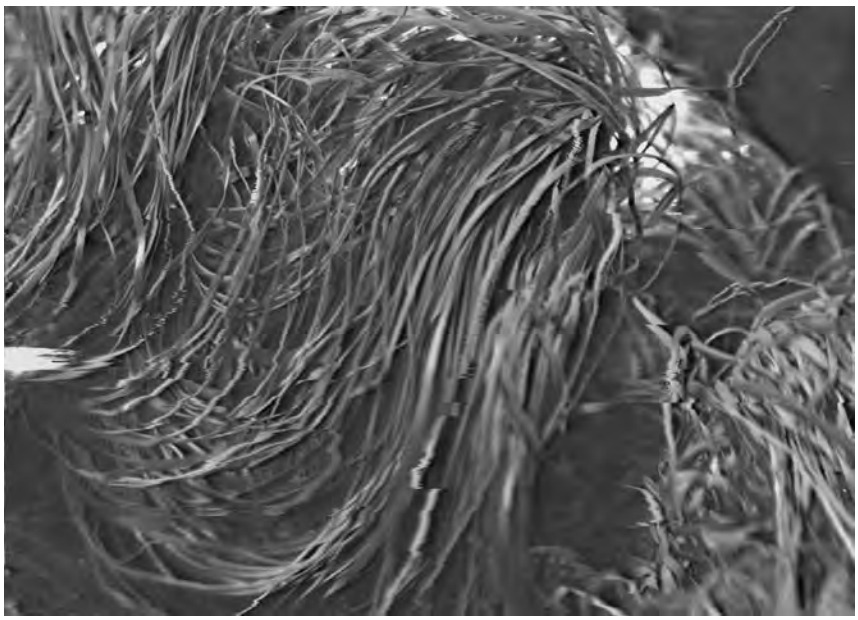

Photo 5: Condition after 100 OTEX washes.

Photo 6: Condition after 100 OTEX washes and drying at 180°F.

Photo 7: Condition after 100 thermal disinfection washes.

4.3 Field Samples:

Samples were taken from a number of sites using microfibres to determine the extent of colour fade in the field with “live” sites. These were taken from a broad spectrum of hospital and nursing home sites where microfibres had been in use for differing periods of time and were being laundered either by traditional thermal wash cycles or with OTEX. The results of the investigation are as follows:

Table 3: COLOUR LOSS

Sample Id:	***Colour***	***Supplier:***	***Batch No:***	***Laundering Details***	***Approx number of washes***	***% Colour Loss***
Addenbrookes Hospital Cambridge	Blue	Johnson Diversey	010.358	Thermal & drying @ 180F	350	19
	Red		010.035			35
Rochdale Infirmary Lancashire	Red		015.026		100	14
Royal Oldham Hospital Lancashire	Blue		015.025	Thermal Not drying items	200	<10
Woodend Hospital, Aberdeen	Blue		015.028	Thermal & drying @ 180F	200	<10
Calderdale Royal Hospital, Halifax	Blue		010.362	As above	200	<10
QEII Welwyn Garden City	Blue		010.674	OTEX & Tumble drying 180F – 130F	100	33
Queen Mary’s Hospital, Sidcup	Blue	EcoLab	No batch number	OTEX & Tumble drying 130F	200	20
Manchester Royal Children’s Hospital Manchester	Green		No batch Number	OTEX & Tumble drying 130F	200	20

Table 3 Continued:

Sample Id:	***Colour***	***Supplier:***	***Batch No:***	***Laundering Details***	***Approx number of washes***	***% Colour Loss***
Millfield Nursing & Residential Home, Heywood	Blue	Johnson Diversey	010.603	OTEX & Tumble Drying @ 180F	250	<10
Kirknowe Nursing Home, Wishaw Scotland	Blue		010.599	OTEX Not drying items	300	27
Lady Sarah Cohen House, Jewish Care N London	Red		010.674	Thermal & Tumble Drying @ 180F	300	15
	Blue		010.720			30
Royal Bolton Hospital, Bolton	Yellow		010.681			30

4.4 Surface Area & Absorbency

The surface area and absorbency of the cloths are pivotal to the performance and effectiveness of these items. A reduction in either of these is likely to reduce its ability to remove soil from the surface with obvious implications. Shrinkage and fibre damage may also affect the effectiveness of the laundering process, with organic matter becoming embedded into the fibre structure. Laboratory tests were conducted on both site samples and laboratory controlled test samples measuring water absorbency and surface area in comparison to new cloths. The results are as follows:

Table 4: % Loss in Surface Area

Number of Cycles	***% Loss in Surface Area (Jonmaster Microfibre Batch No: 010:754)***		
	OTEX Wash Only	**OTEX & Tumble Dried at 180F**	**Thermal Disinfection @ 75C & Tumble Dried at 180F**
100	4	10	17

Table 5: % Loss in Absorbency

Number of Cycles	***% Loss in Absorbency (Jonmaster Microfibre Batch No: 010:754)***		
	OTEX Wash Only	**OTEX & Tumble Dried at 180F**	**Thermal Disinfection @ 75C & Tumble Dried at 180F**
100	5	18	26

Table 6:Surface Area & Absorbency

Sample Id:	***Laundering Details***	***Approx number of washes***	***% Loss in Surface Area***	***% Loss in Absorbance***
Addenbrookes Hospital Cambridge	Thermal & drying @ 180F	350	21	50
Rochdale Infirmary Lancashire		100	13	50
Royal Oldham Hospital Lancashire	Thermal Not drying items	200	6	40
Woodend Hospital, Aberdeen	Thermal & drying @ 180F	200	44	45
Calderdale Royal Hospital, Halifax	Thermal & drying @ 180F	200	33	33
QEII Welwyn Garden City	OTEX & Tumble drying 180F – 130F	100	5.0	17
Queen Mary's Hospital, Sidcup	OTEX & Tumble drying 130F	200	1.0	17
Manchester Royal Children's Hospital Manchester	OTEX & Tumble drying 130F	200	11	33
Millfield Nursing & Residential Home, Heywood	OTEX & Tumble Drying @ 180F	250	1.5	No loss in absorbency
Kirknowe Nursing Home, Wishaw Scotland	OTEX Not drying items	300	5	15
Lady Sarah Cohen House, Jewish Care N London	Thermal & Tumble Drying @ 180F	300	18	33
Royal Bolton Hospital, Bolton		300	23	42

5. SCIENTIFICS LTD ELECTRON MICROSCOPE IMAGING

Samples collected from “live” sites were submitted to Scientifics Ltd in Derby for independent assessment for chemical damage and to provide electron microscope imaging. The findings are given as follows with the images appended to the report.

Table 7:

Sample Id:	***Laundering Details***	***Scientifics Reference No:***	***Scientifics Findings on Fibre Appearance***
Addenbrookes Hospital Cambridge	Thermal & drying @ 180F	Jul05	Twisted/kinked fibres indicative of physical/heat damage. No evidence of chemical erosion/damage.
Rochdale Infirmary Lancashire		F2111/06BC	Ribbon like fibres, a few twisted/damaged fibres, indicative of physical/heat damage. No evidence of chemical erosion/damage
Royal Oldham Hospital Lancashire	Thermal Not drying items	F2111/06/D	Ribbon like fibres, almost no damage to the fibres noted. No evidence of chemical erosion/damage
Woodend Hospital, Aberdeen	Thermal & drying @ 180F	oct06 ab	Twisted/kinked fibres indicative of physical/heat damage. No evidence of chemical erosion/damage.
Calderdale Royal Hospital, Halifax		F2111/06/EF	Twisted/kinked fibres indicative of physical/heat damage. No evidence of chemical erosion/damage.
QEII Welwyn Garden City	OTEX & Tumble drying 180F – 130F	F03256	Ribbon like fibres, virtually no damage/twisting noted. No evidence of chemical erosion/damage.

Sample Id:	***Laundering Details***	***Scientifics Reference No:***	***Scientifics Findings on Fibre Appearance***
Queen Mary's Hospital, Sidcup	OTEX & Tumble drying 130F	oct06abc	Ribbon like fibres, virtually no damage/twisting noted. No evidence of chemical erosion/damage.
Manchester Royal Children's Hospital Manchester	OTEX & Tumble drying 130F	oct06 ab	Ribbon like fibres, virtually no damage/twisting noted. No evidence of chemical erosion/damage.
Millfield Nursing & Residential Home, Heywood	OTEX & Tumble Drying @ 180F	F2111/06/G	Majority of fibres are undamaged and still in groups of loops. All damage noted in concentrated areas indicative of heat damage. No evidence of chemical erosion/damage.
Kirknowe Nursing Home, Wishaw Scotland	OTEX Not Drying Items	F2166/06/JH2	Virtually no damage noted to fibres, where they are damaged it is simply twisting of fibres.
Lady Sarah Cohen House, Jewish Care N London	Thermal & Tumble Drying @ 180F	F2111/06/JK	Almost all fibres are damaged, in some areas severely, this includes breakages and knotted clusters. Physical/heat damage. No evidence of chemical erosion/damage
Royal Bolton Hospital, Bolton		F0156/07	The loops of fibres are still tightly bunched together with only occasional loose strands. Broad bending of physical wear and tear. A number of fibres were shown to be broken.

5. CONCLUSIONS & RECOMMENDATIONS

This study was conducted to compare the condition of microfibre cloths used within the healthcare environment following differing disinfection wash processes and numbers of wash cycles. The objective being to establish whether thermal or ozone disinfection wash processes have any detrimental effect on the integrity of the microfibre and subsequent effectiveness. OTEX provides a superior disinfection laundering process in comparison to thermal disinfection. Additional work carried out on the microbiological performance of thermal in comparison to OTEX has shown that there is a higher incidence that spore forming bacteria for example C.diff to be present following thermal disinfection than OTEX.

Laboratory tests have been conducted on new microfibre cloth samples to assess the effect from exposure to ozone gas and ozonated water. In addition numerous samples from a broad range of hospital and nursing home sites have also been examined to determine the extent of colour loss and potential fibre damage. Independent examination of the samples has also been obtained from Scientifics Ltd, Forensic section at Derby. The results indicate:

- Colour loss is experienced irrespective of either washing under current HSG guidelines utilising thermal disinfection or OTEX, ozone disinfection wash cycles.

- No association between colour loss and fibre damage resulting in a reduced performance has been found. This has been supported by information on colour loss supplied by one of the microfibre manufacturers.

- No chemical damage/erosion was found in any of the samples submitted to Scientifics Ltd.

- There is evidence supported by Scientifics Ltd that physical damage has occurred. The damage being localised on the tips of the fibres and indicative of exposure to high temperatures during the drying process. It is interesting to note that Scientifics report shows that the cloths processed with OTEX exhibit <u>less</u> damage.

- The effect of physical damage can be seen in the loss of the original surface area together with a corresponding reduction in the original absorbency. The physical damage is likely to be as a result of drying at high temperatures for prolonged periods, since essentially the cloths are polymers or "plastic" and are therefore susceptible to heat. Processing mops and cloths together will also have a detrimental effect on the cloths by increasing the physical action or abrasion of the processes.

The results have clearly shown that the use of OTEX does not result in any detrimental effect to the microfibre effectiveness or integrity and is a viable alternative to thermal disinfection. In contrast there is evidence that the use of ozone has maintained the microfibre integrity with the added benefit of an improved disinfection process and additional utility savings.

Loss in colour has been experienced with both processes. Given the importance of retaining colour throughout the life of the cloth it is recommended that an investigation into alternative dyes is carried out. The use of dyes resistant to oxidising agents; vat dyes for example should be explored.

Clear guidance needs to be given by the supplier and manufacturer as to the recommended drying temperature. Care labels attached to the cloths give inconsistent guidelines on washing and drying temperatures these need to be standardised throughout the industry.

Specific drying programs have now been developed by JLA and are being employed at a number of sites laundering microfibre. This uses a lower drying temperature of 130^{o}F in comparison to common practice of drying at 180^{o}F. No detrimental effect to the microfibre has been experienced at any of these sites.

It is strongly recommended that staff are fully conversant with the laundering needs of microfibres. Full training and advice should be introduced at all sites. All dryers on site should have clear instruction on their programs including drying temperatures, laundry sorting and times. Where applicable microfibre specific drying programs should be adopted.

6. References

1. Jonmaster Customer Presentation. Johnson Diversey.

2. Chemical Principles of Synthetic Fibre Dyeing. S.M. Burkinshaw.

3. Recommendations from ACT® for washing cycle. Actex®, source and date unknown.

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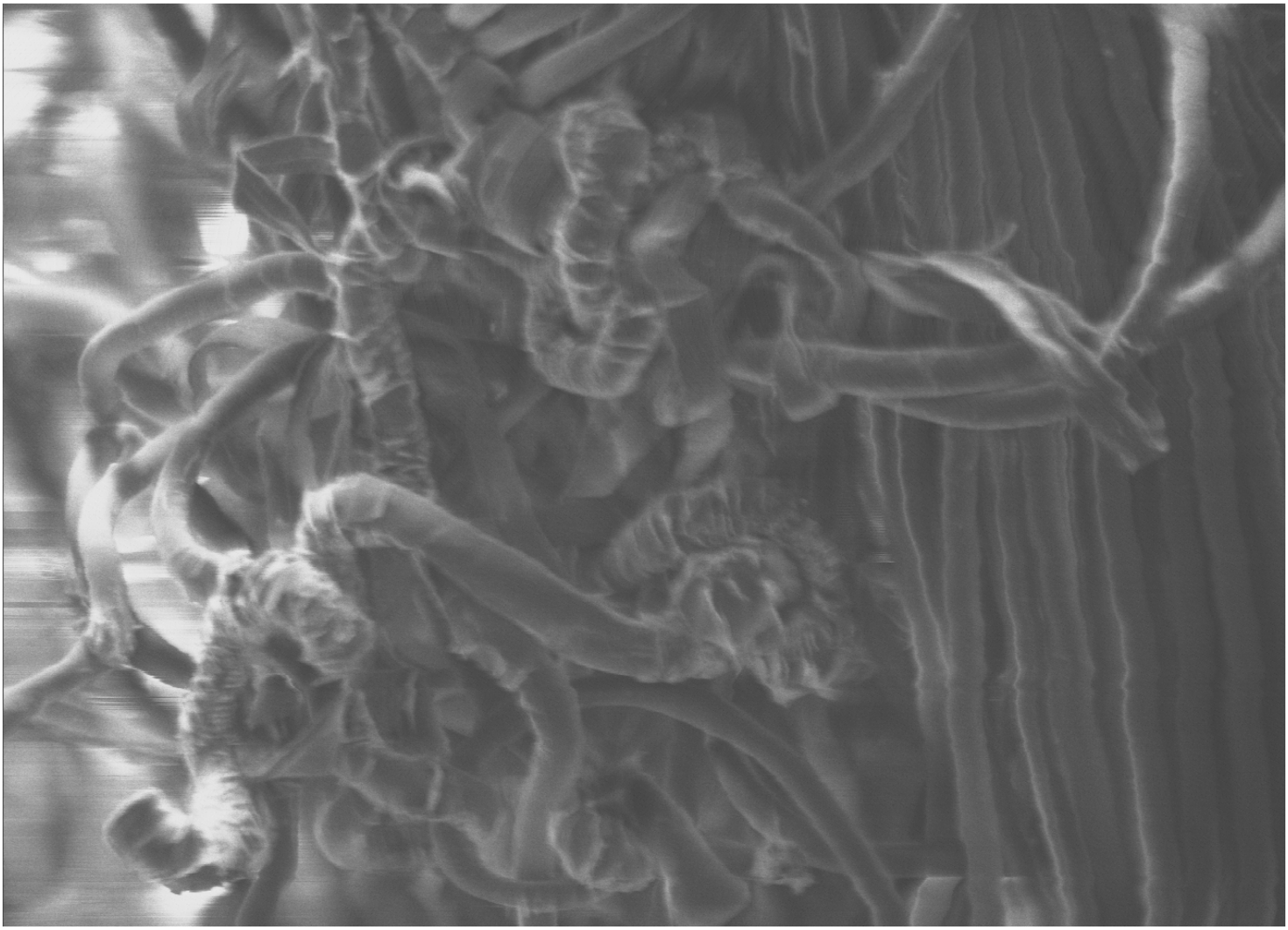
APPENDIX A
SCIENTIFICS LTD SEM IMAGES

SITE ID	*SCIENTIFICS REPORT REF*
Addenbrooke's Hospital, Cambridge	*JUL05*
PROCESS	*THERMAL & DRIED 180^{O}F*



SITE ID	SCIENTIFICS REPORT REF
Rochdale Infirmary, Rochdale Lancashire	F2111/06BC
PROCESS	THERMAL & DRIED 180^{O}F

SITE ID	SCIENTIFICS REPORT REF
Royal Oldham Hospital, Oldham Lancashire	F2111/06D
PROCESS	THERMAL NOT DRYING

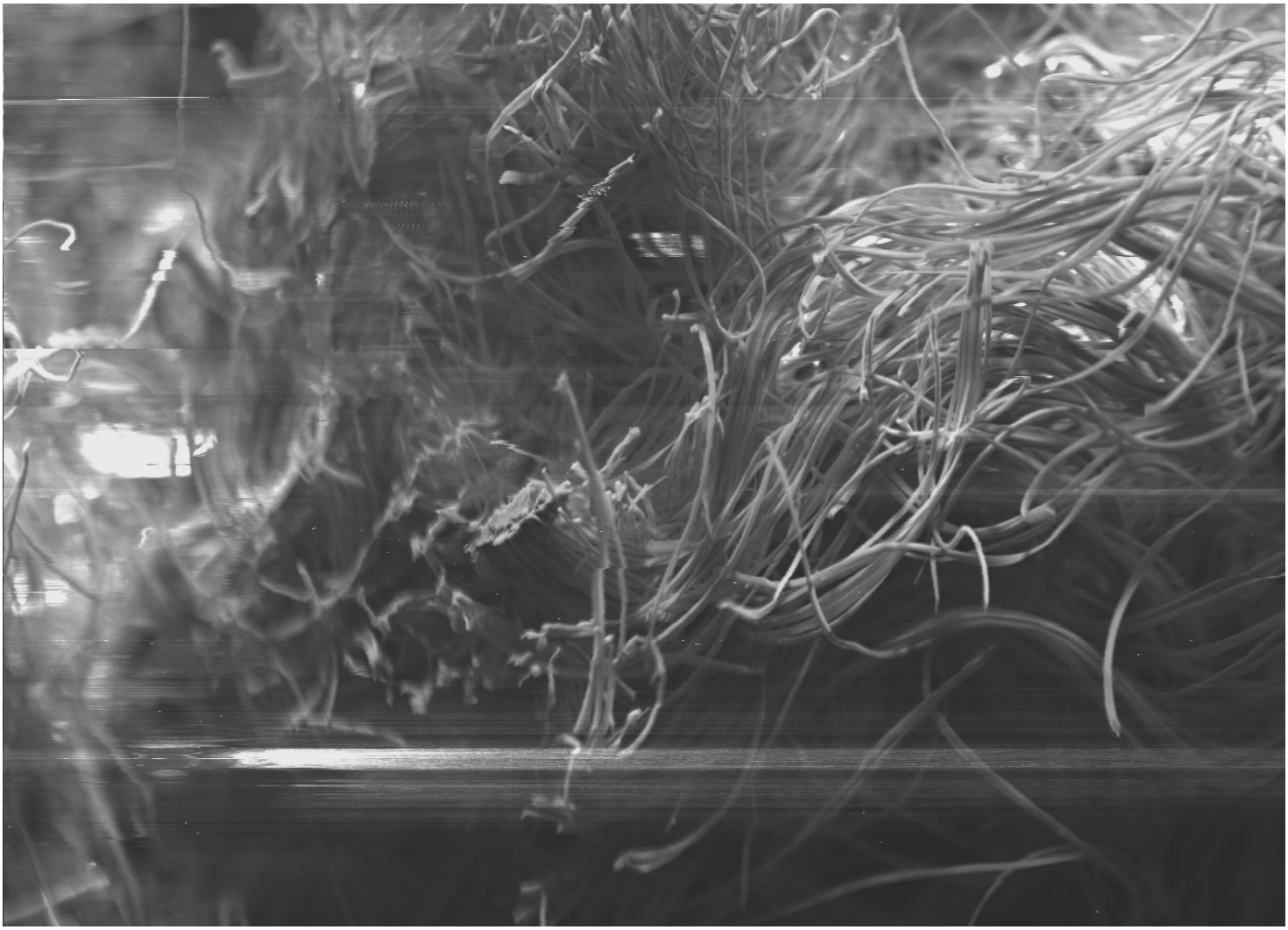
SITE ID	SCIENTIFICS REPORT REF
Woodend Hospital, Aberdeen	OCT06AB
PROCESS	THERMAL & DRIED 180^{O}F

SITE ID	SCIENTIFICS REPORT REF
Calderdale Royal Hospital, Halifax	F2111/06EF
PROCESS	THERMAL & DRIED 180^{O}F

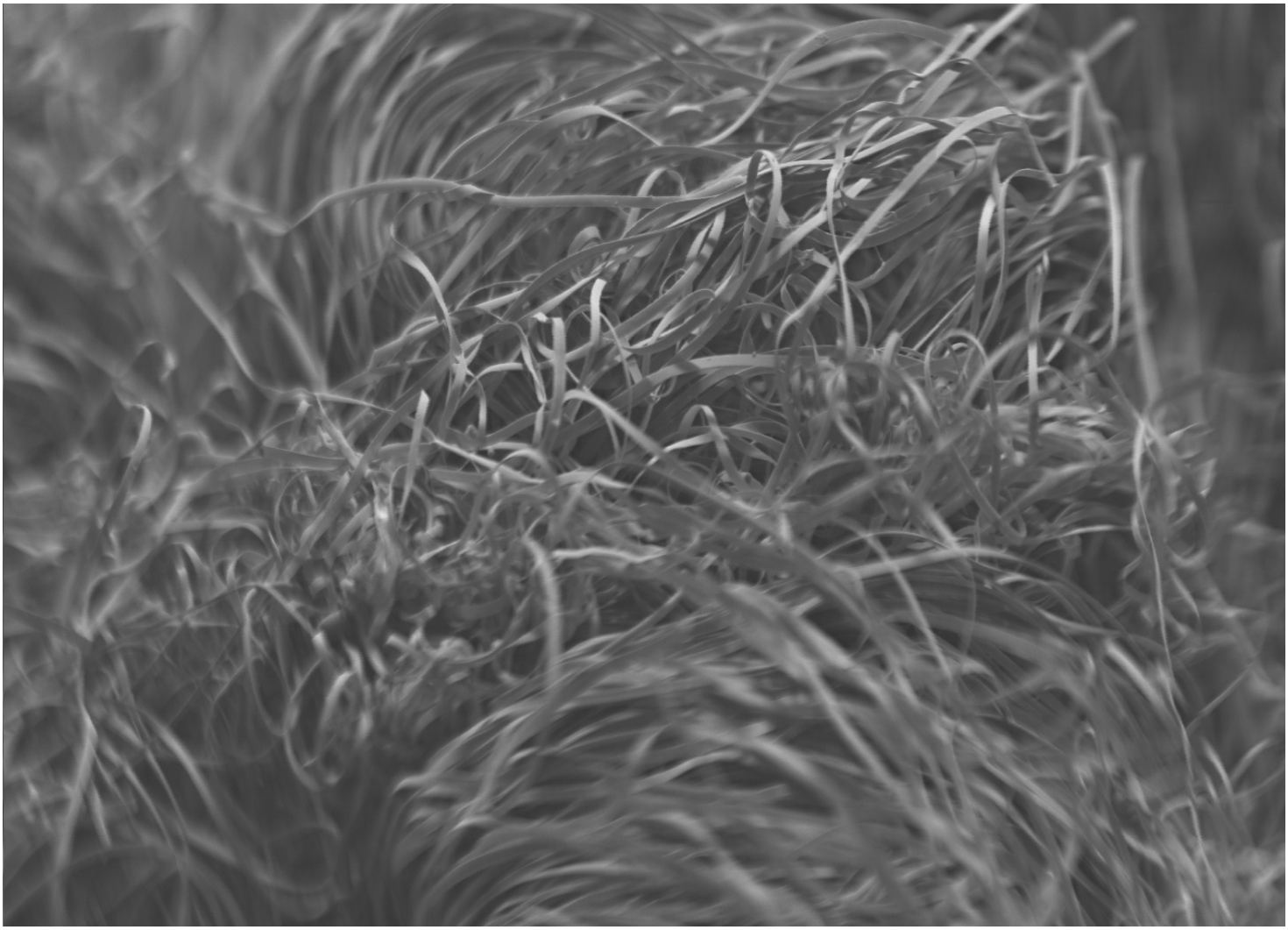
SITE ID	SCIENTIFICS REPORT REF
QEII Welwyn Garden City	F03256
PROCESS	OTEX & DRIED 180^{O-} - 130^{O-} F

SITE ID	SCIENTIFICS REPORT REF
Queen Mary, Sidcup	OCTO6ABC
PROCESS	OTEX TUMBLE DRIED 130^{O} F

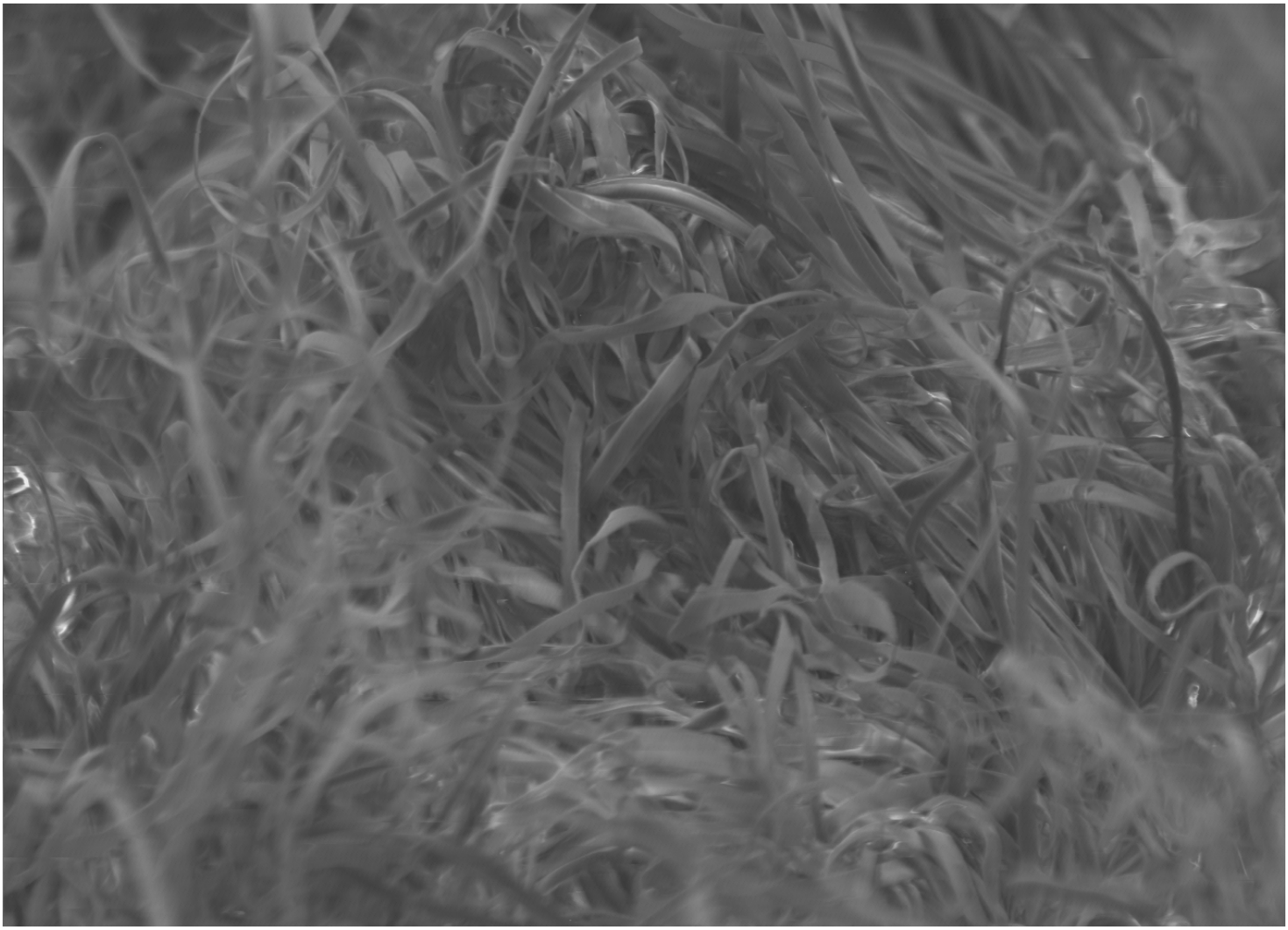
SITE ID	SCIENTIFICS REPORT REF
Manchester Royal Children's Hospital	OCT06AB
PROCESS	OTEX TUMBLE DRIED 180^{O} F



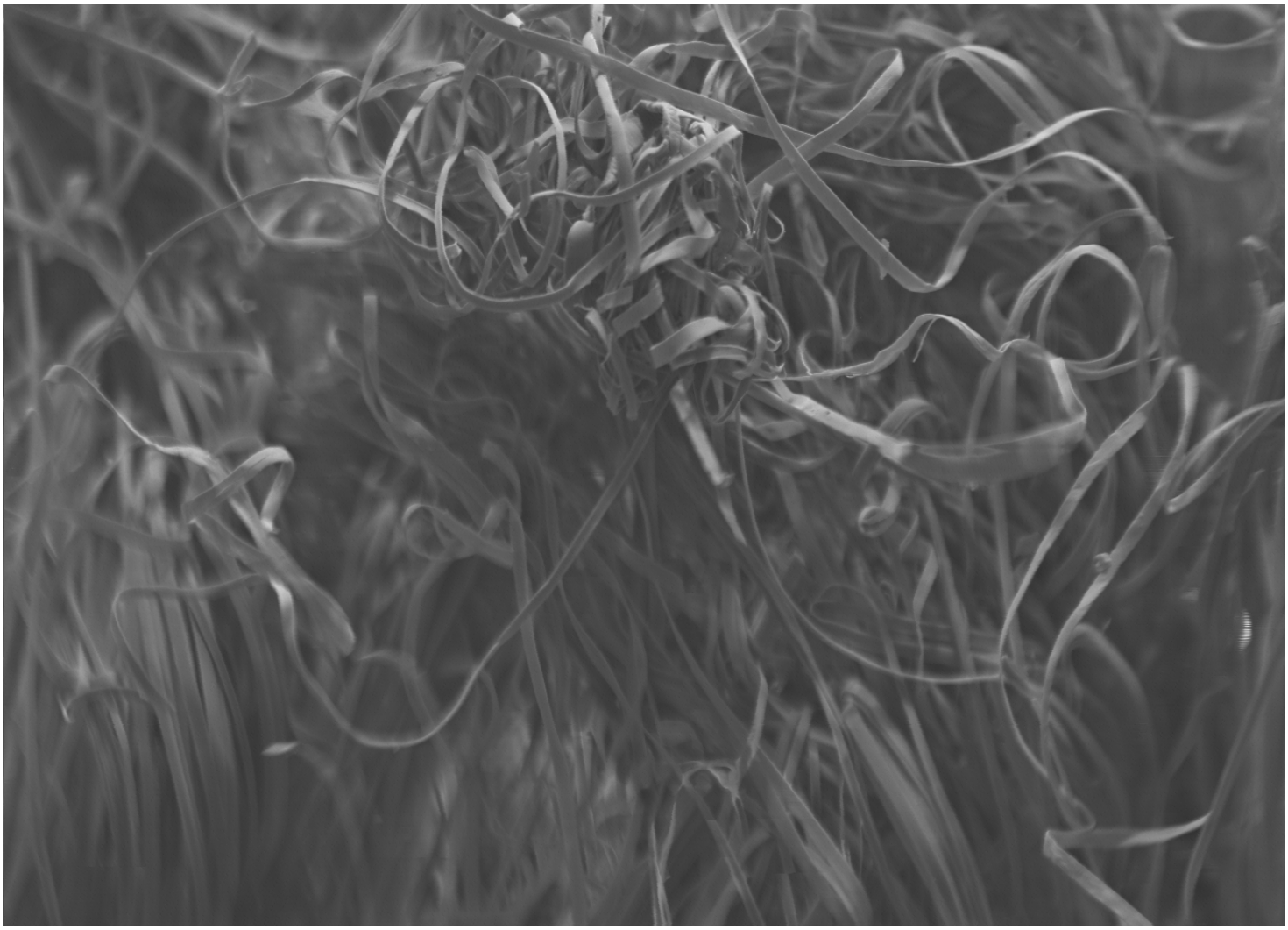
SITE ID	SCIENTIFICS REPORT REF
Millfield Nursing & Residential Home, Heywood, Lancashire	F2111/06/G
PROCESS	OTEX TUMBLE DRIED 180^{O} - F



SITE ID	SCIENTIFICS REPORT REF
Kirknowe Nursing Home Wishaw, Scotland	F2166/06/JH1
PROCESS	OTEX NOT DRYING ITEMS



SITE ID	SCIENTIFICS REPORT REF
Lady Sarah Cohen House, Jewish Care, North London	F2111/06/JK
PROCESS	THERMAL & TUMBLE DRIED 180^{O} - F



SITE ID	SCIENTIFICS REPORT REF
Royal Bolton Hospital, Bolton Lancashire	F0156/07
PROCESS	THERMAL & TUMBLE DRIED 180^{O} - F