

Contrast-enhanced micro-computed tomography and scanning electron microscopy for visualization of microfibrillated cellulose in paper

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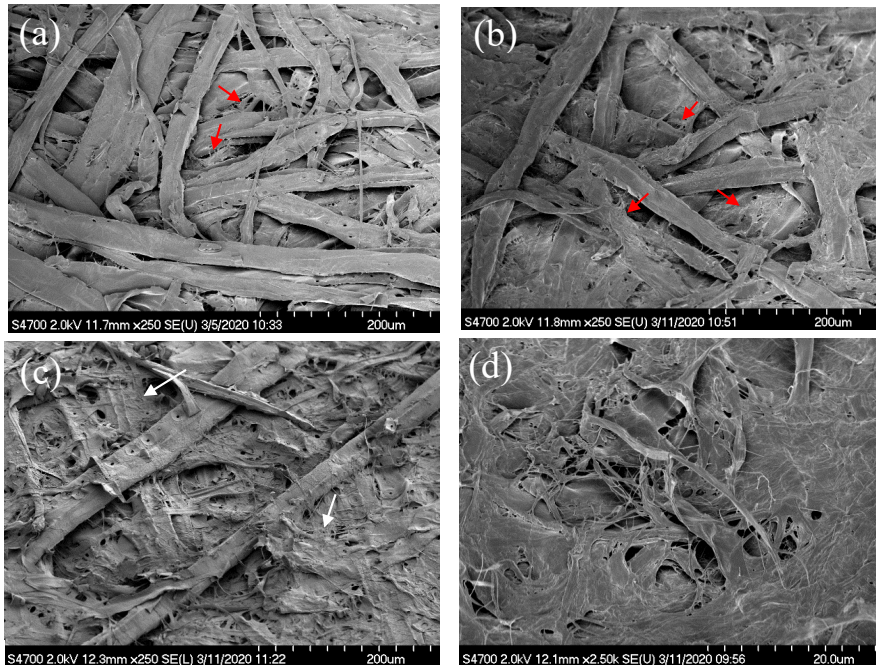
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INTRODUCTION



- The mechanical paper industry has recently faced a severe decline in paper consumption due to the revolution in paperless communications.

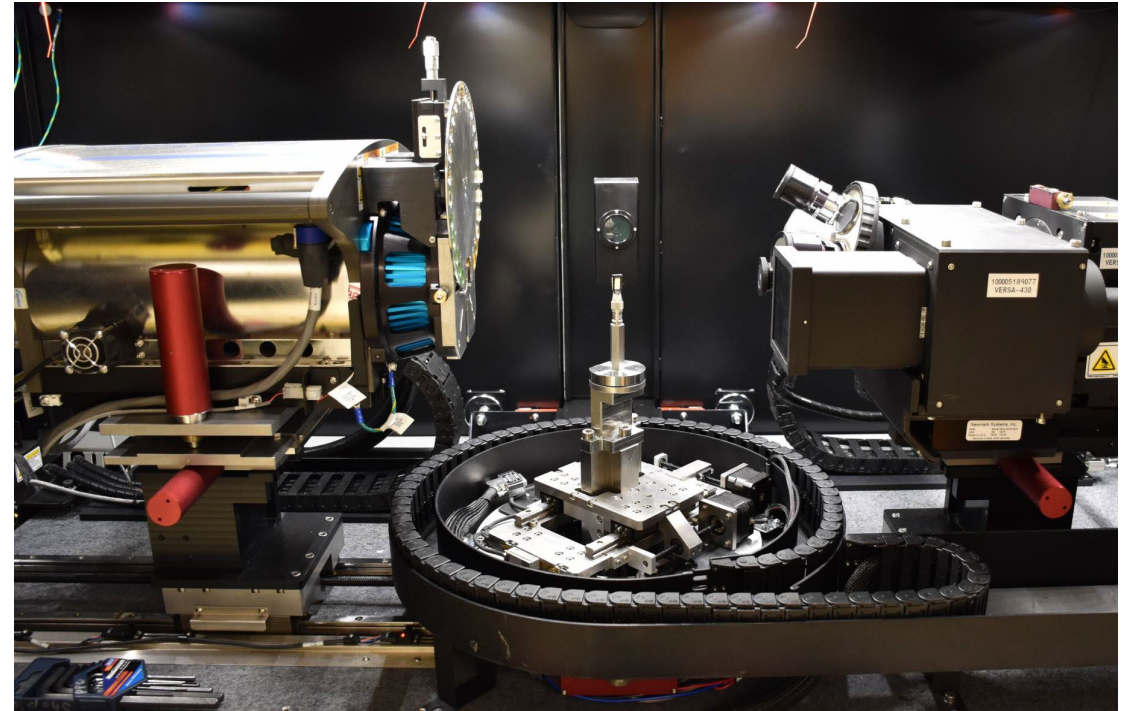
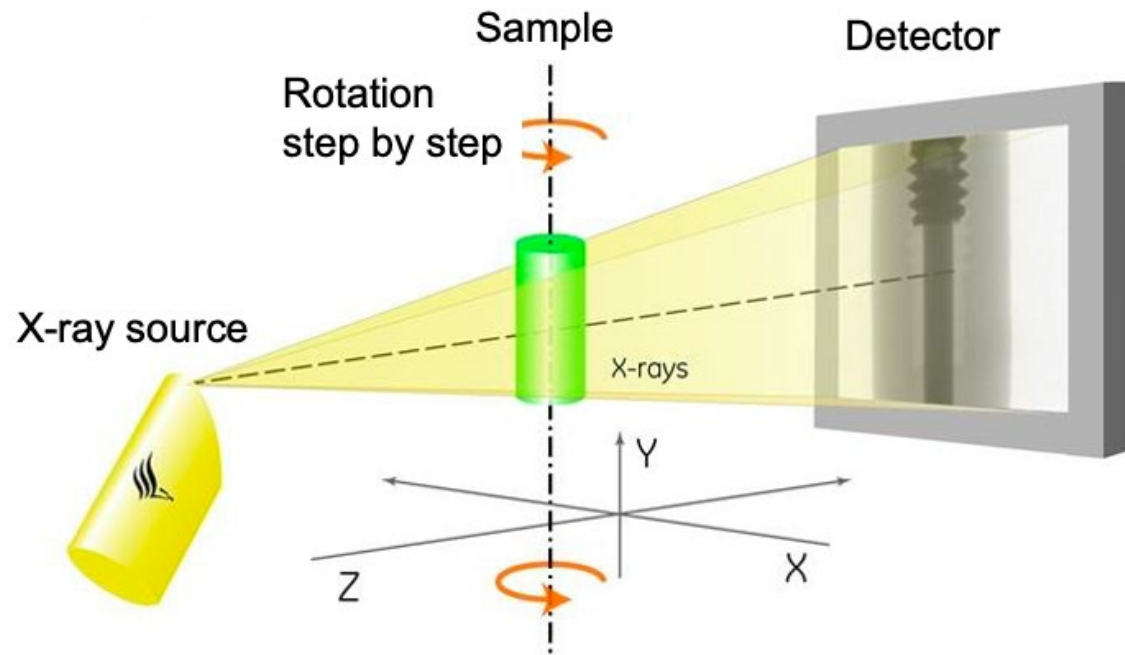


- Microfibrillated cellulose (MFC) has gained intensive interest in the paper industry. Given its high aspect ratio, MFC can affect fiber interactions and alter paper properties. Nevertheless, the effect of MFCs on the paper specifications is not clear yet, in particular, it has been challenging to elucidate the distribution of MFC inside the paper structure.

CHALLENGES AND POTENTIAL SOLUTIONS

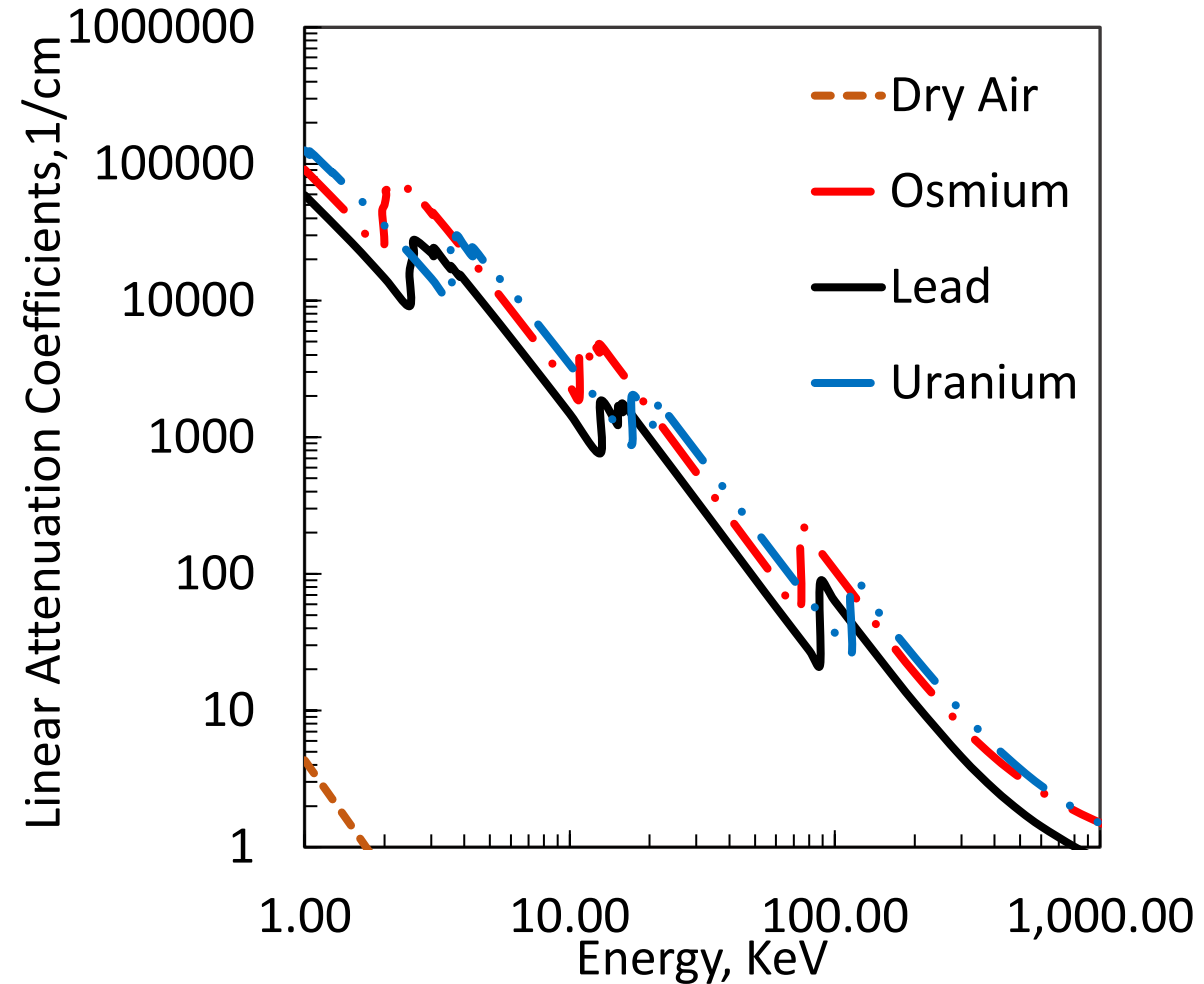
- Owing to the Chemical similarity between MFC and long fibers, differentiation between them is challenging.
- A potential solution is to increase the contrast which in CT scan translates to increase the attenuation coefficient of one of the components. To do this, we stain or label the sample. In addition, a combination of imaging techniques can be used.
- Stain selection

X-RAY MICRO-COMPUTED TOMOGRAPHY (CT- SCAN)

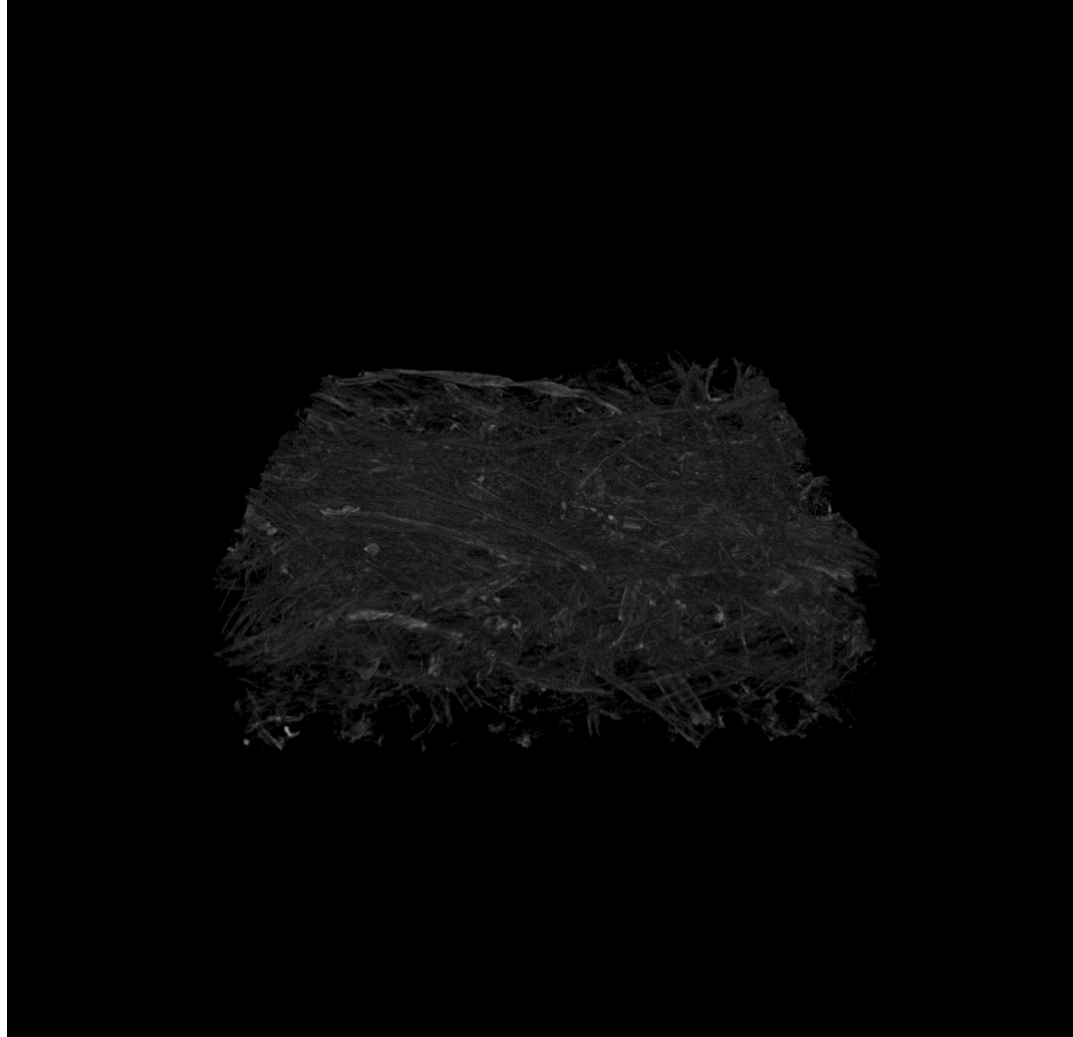


MFC STAINING

- ✓ Osmium tetroxide (Os) + Uranyl acetate (UA)+ Lead citrate (L)
- ✓ Os is used in electron microscopy as a contrast enhancer. UA stains negatively charged molecules. Lead citrate is used as an enhancer for heavy metal staining in electron microscopy. It binds to Os and UA and enhances contrast in many structures.



3-D CONSTRUCTION: STAINED MFC (25%)



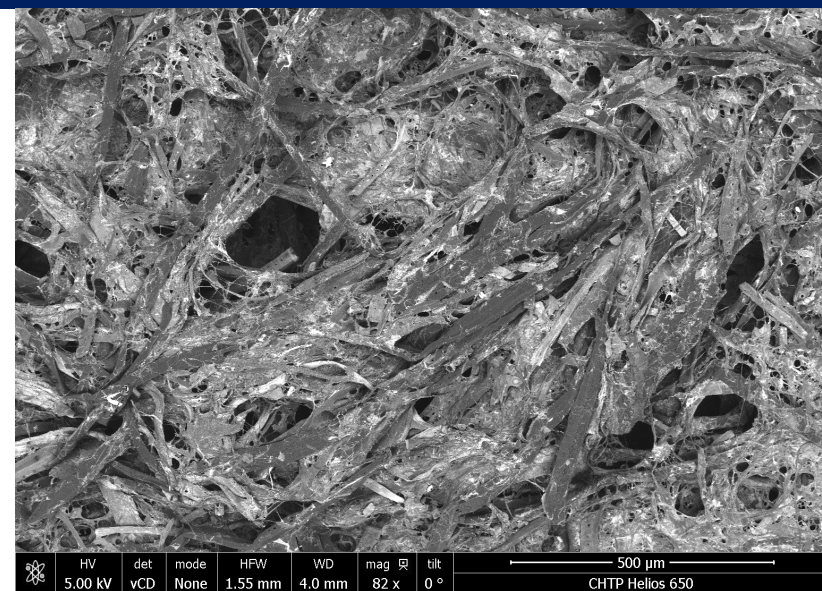
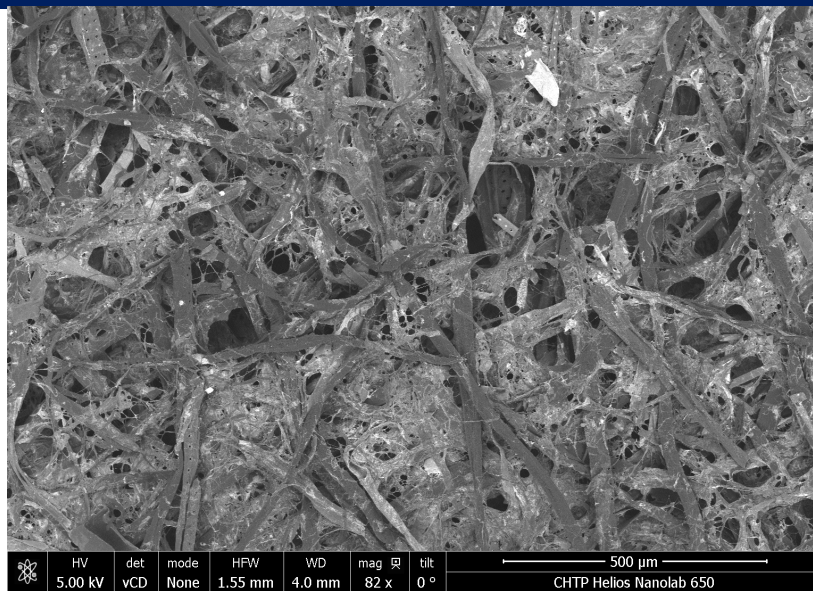
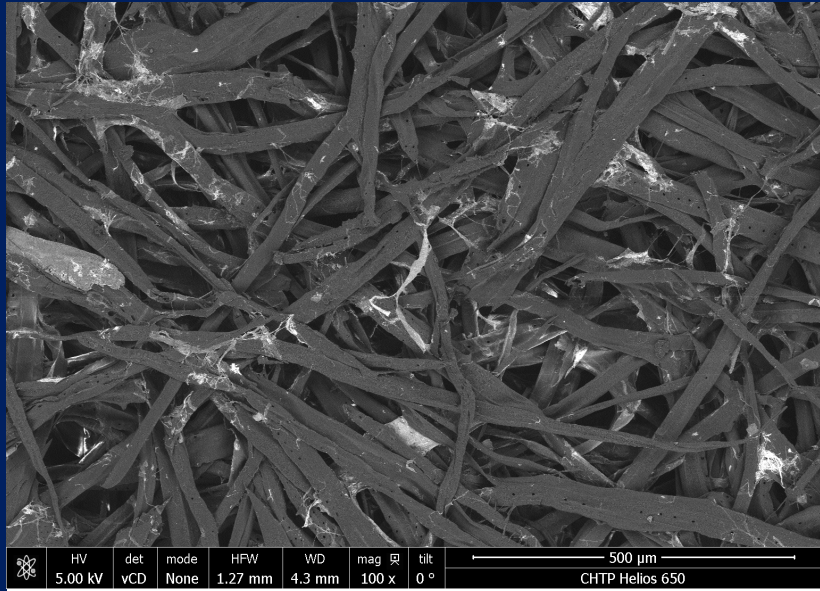
STAINED MFC COMBINED WITH LONG FIBERS

~5% MFC

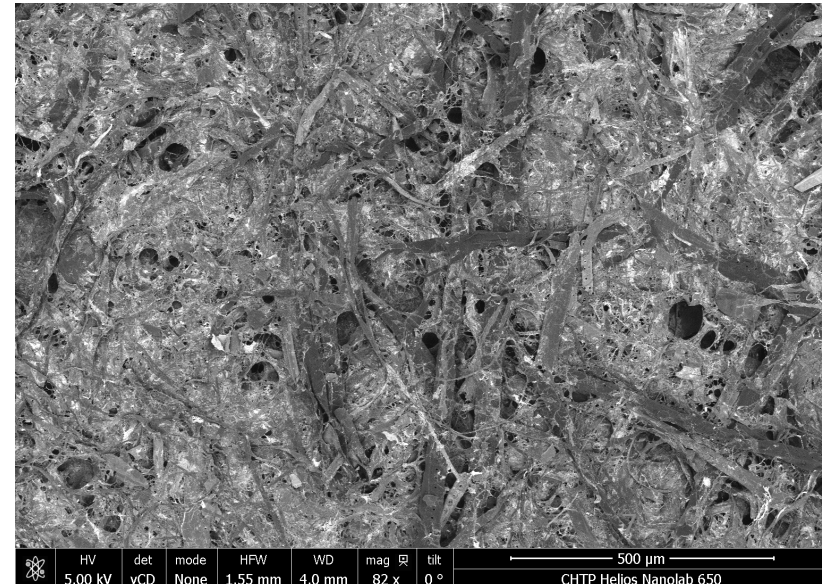
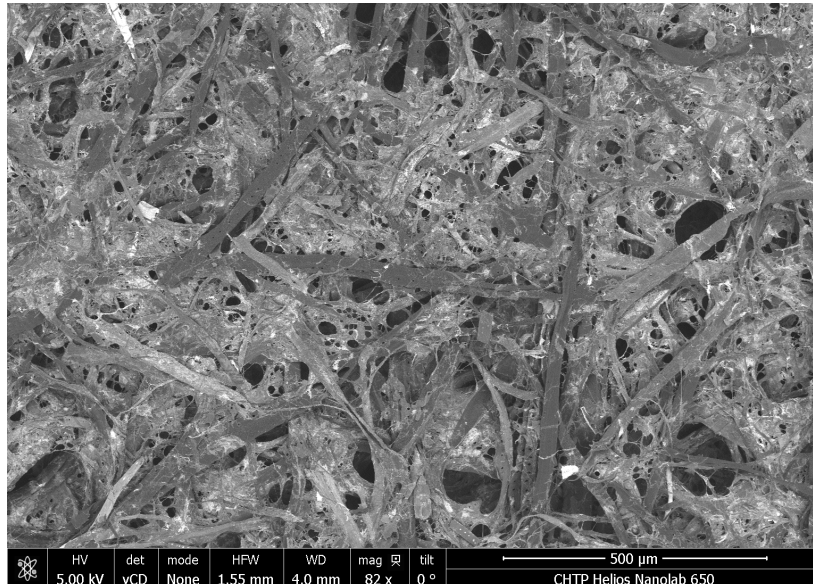
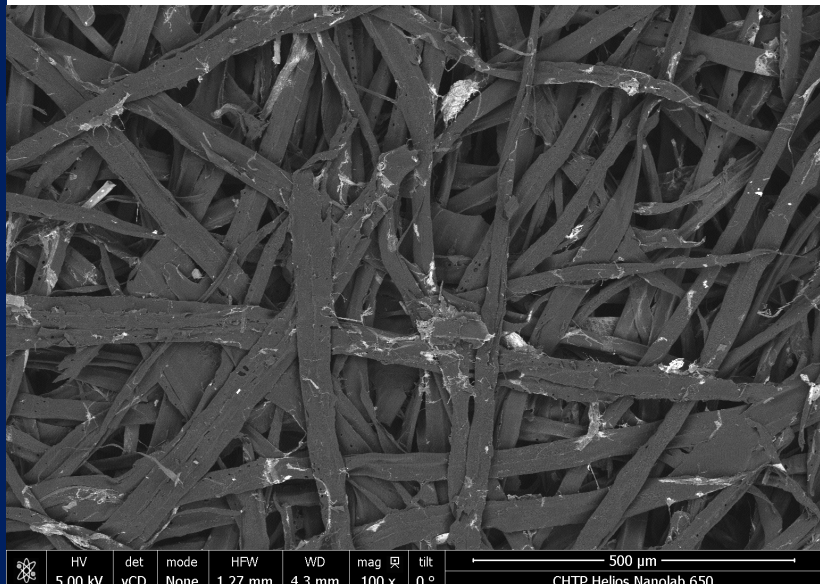
25% MFC

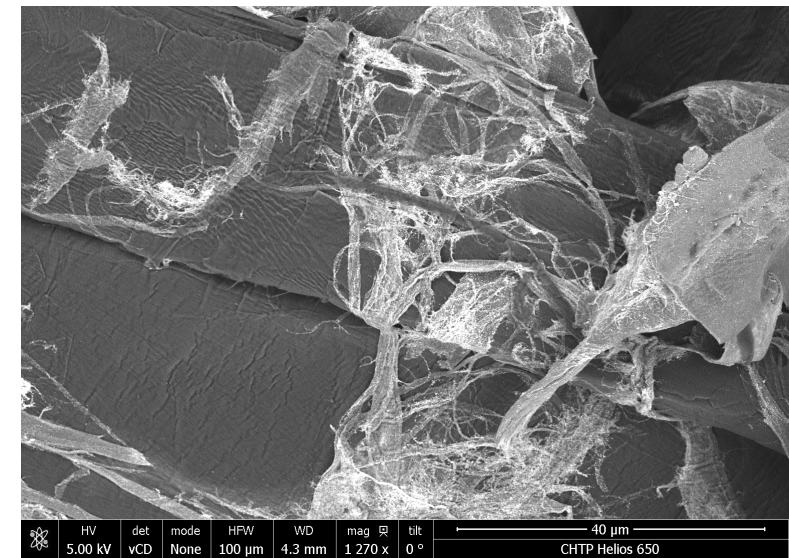
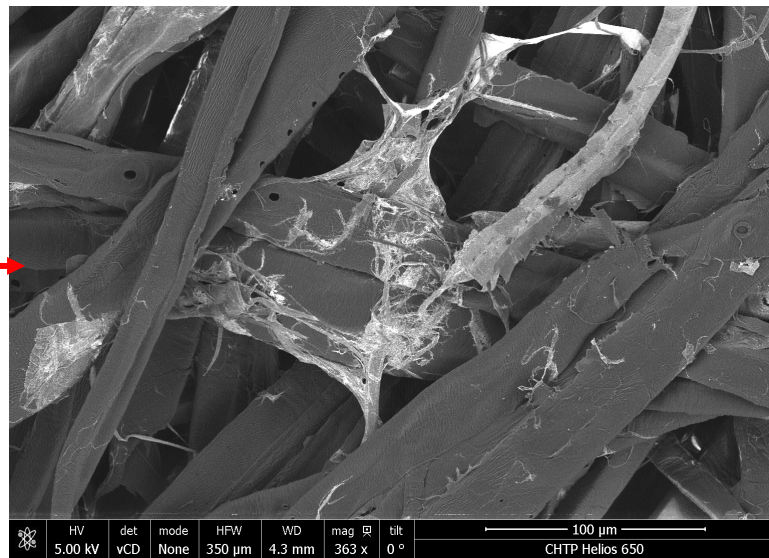
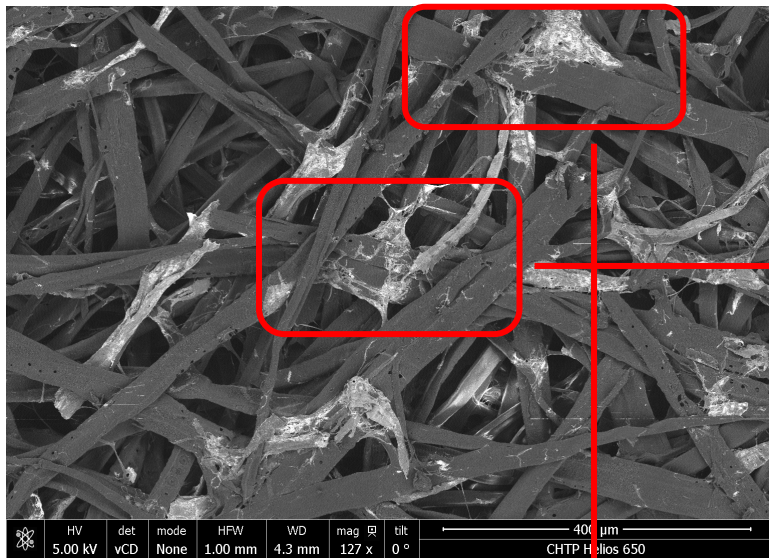
50% MFC

Top surface

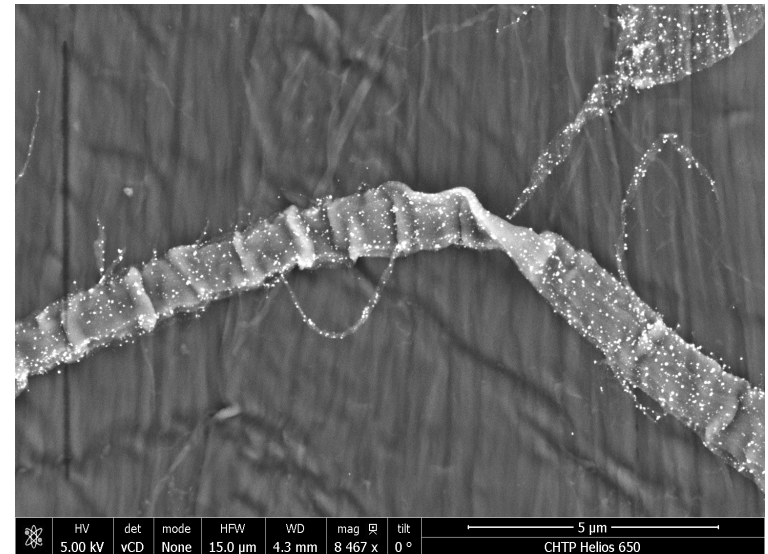
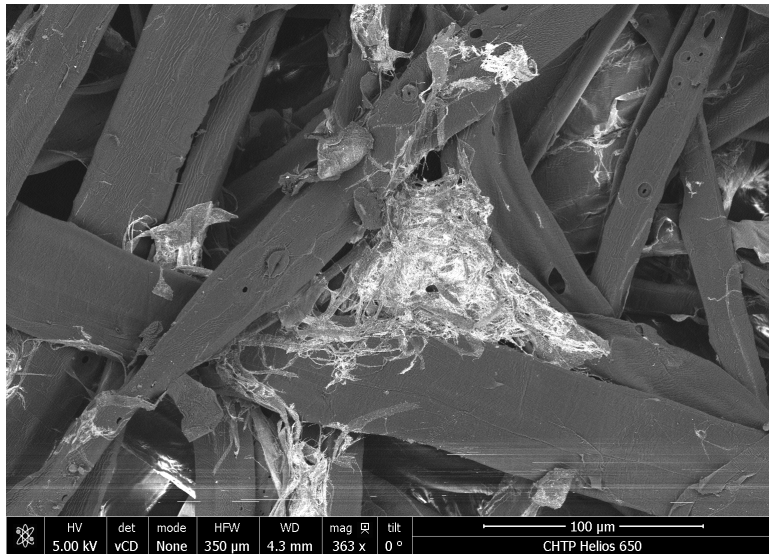


Bottom surface





Enveloped the fibers



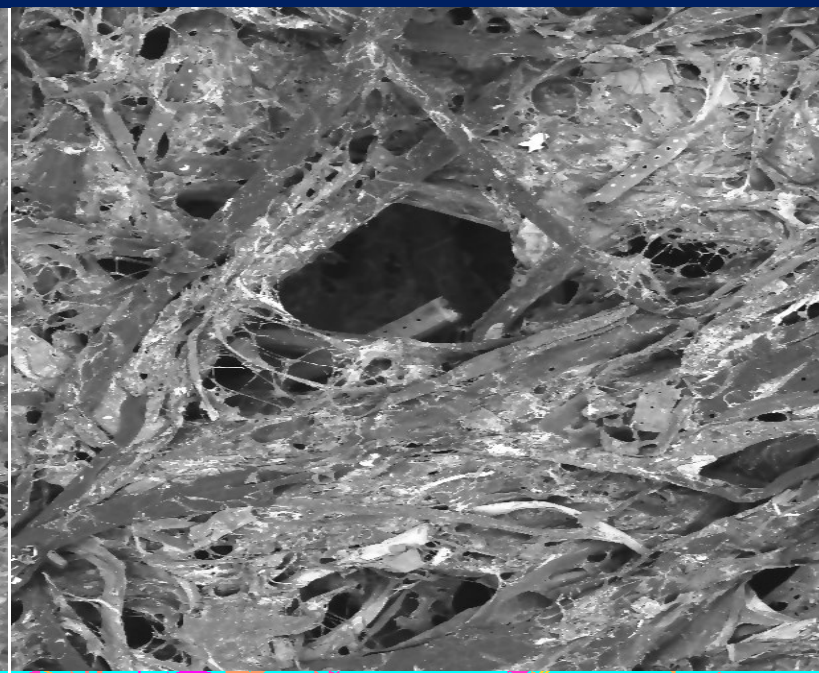
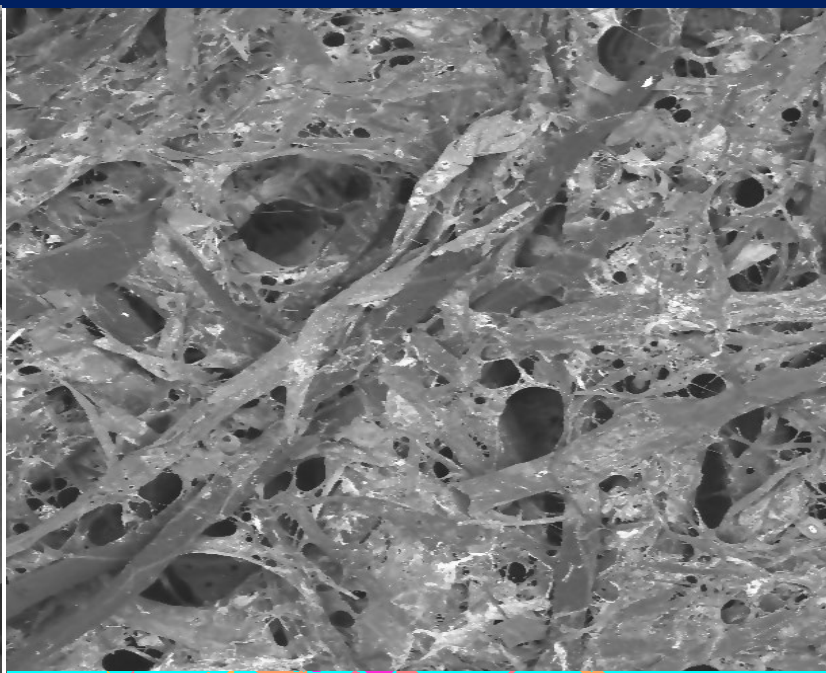
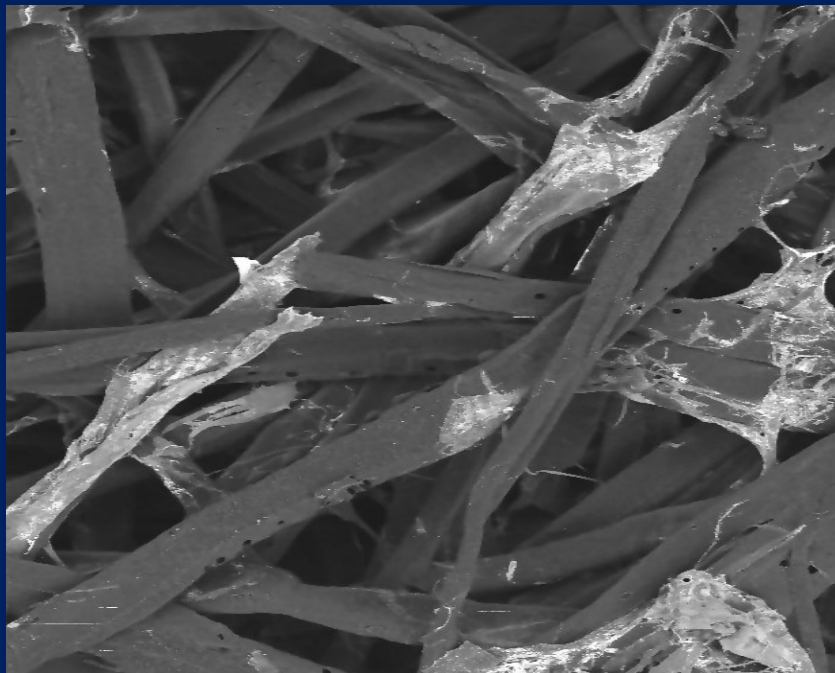
Top surface: Thread like, strong enough to form a narrow bridge between two fibers.

~5% MFC

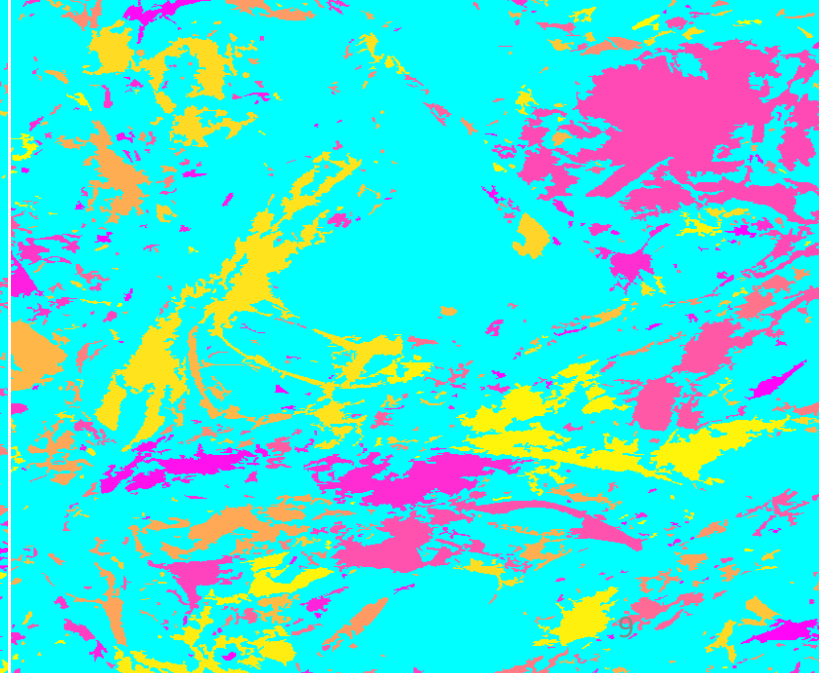
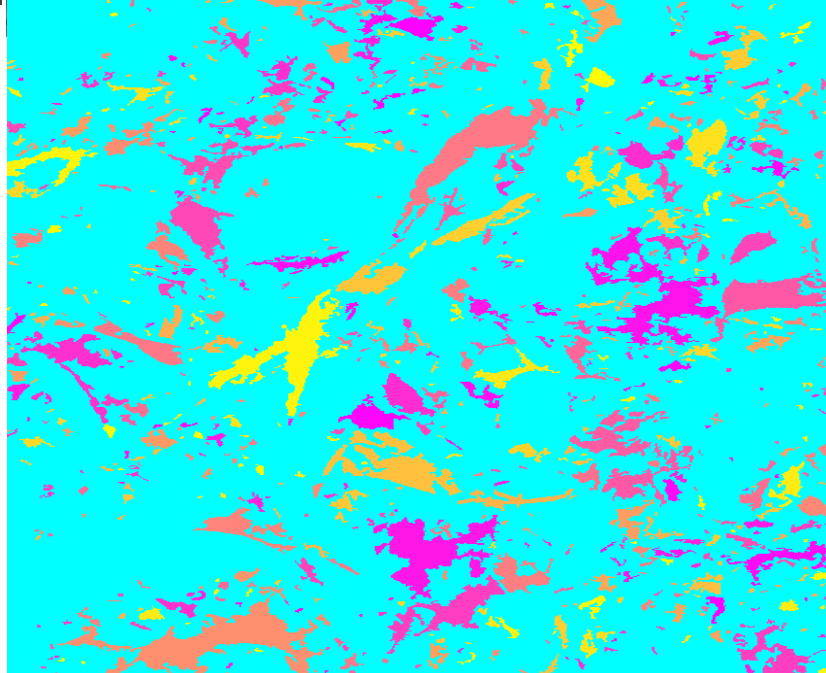
25% MFC

50% MFC

Top surface



Labelled MFCs

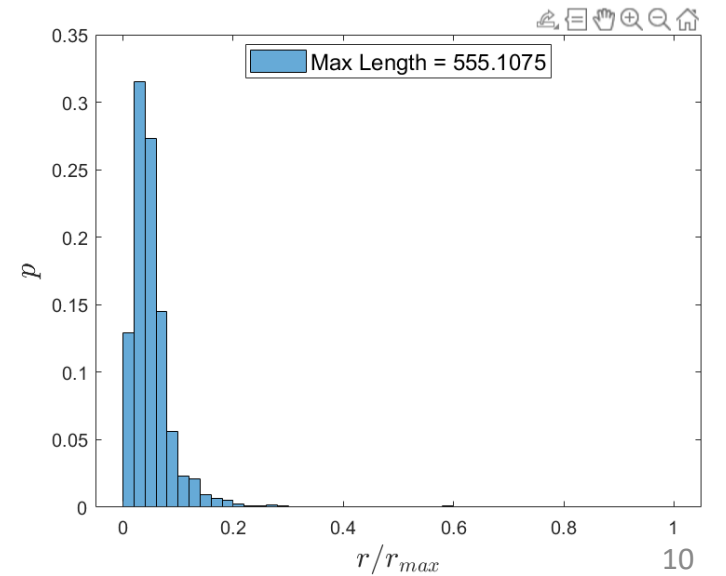
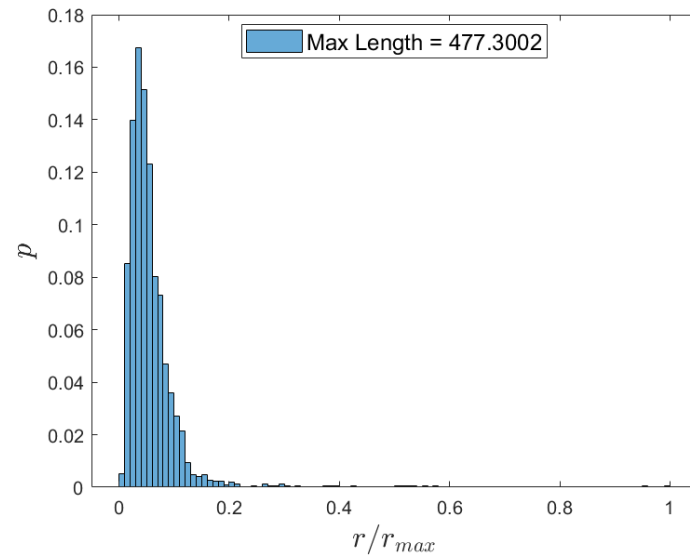
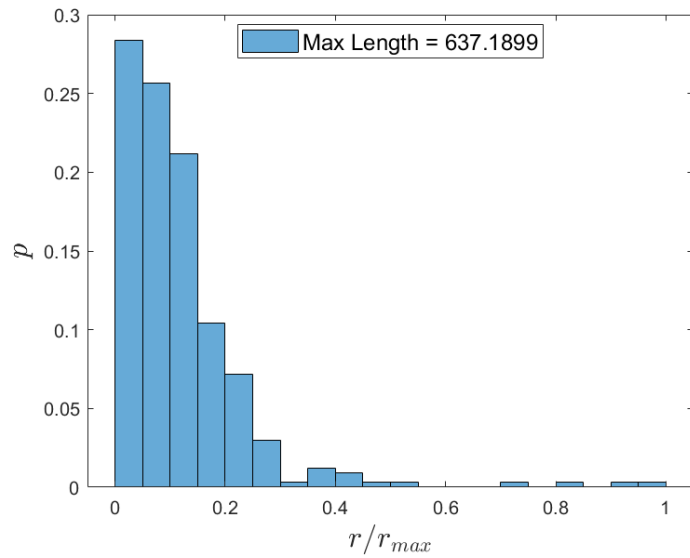
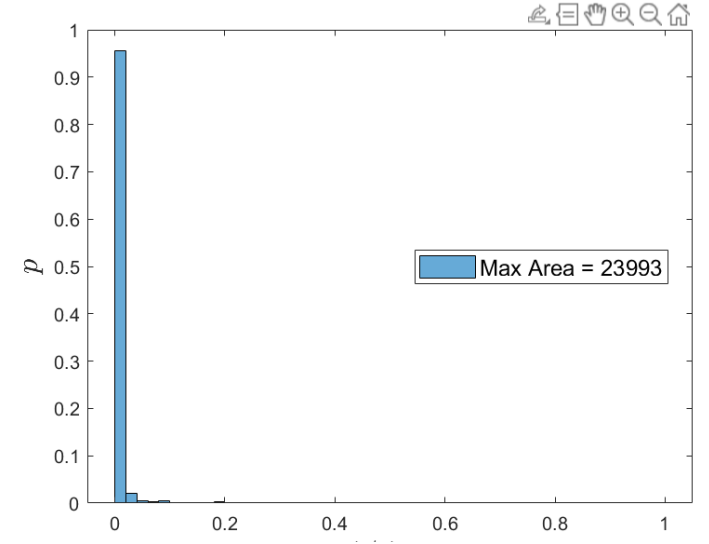
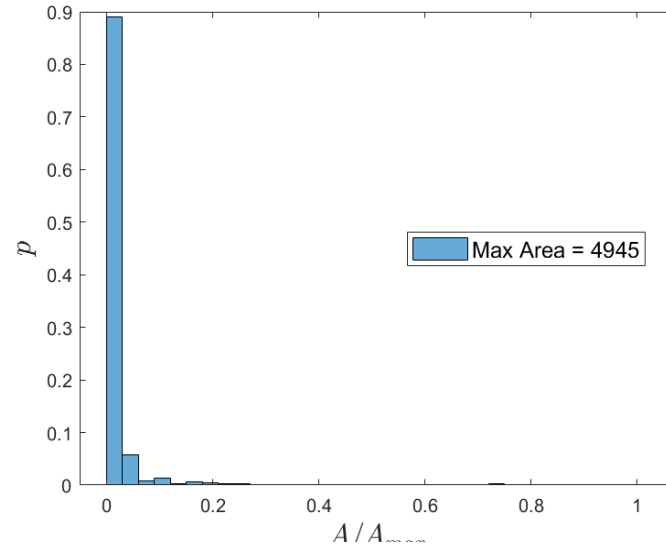
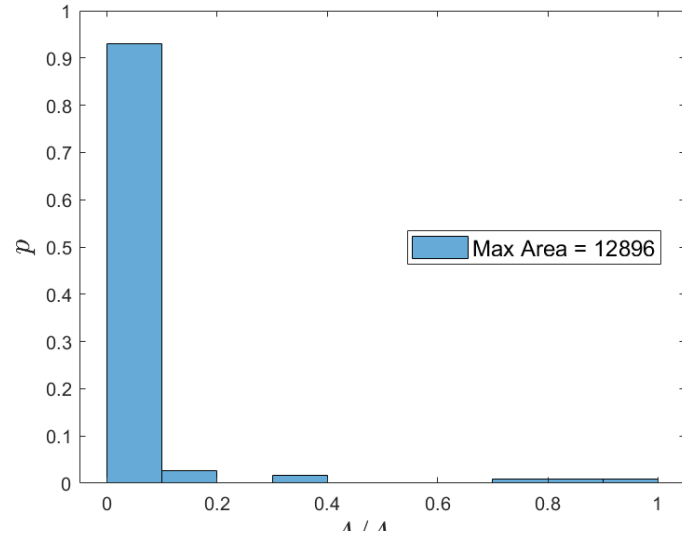


BLOB AREA AND DISTANCE BETWEEN BLOB (TOP SURFACE)

~5% MFC

25% MFC

50% MFC



Thank you