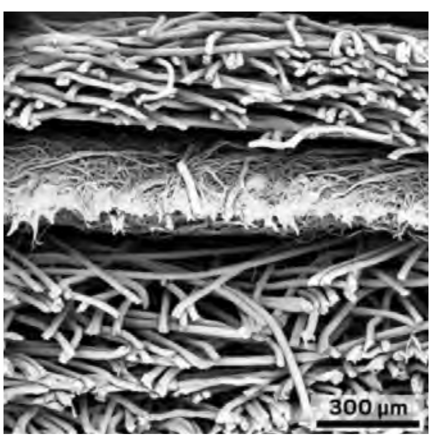
METAL COATING OF A FACE MASK FOR ENHANCED SEM IMAGING

WHERE ARE FACE MASKS USED?

The term "face mask" refers to a number of protective equipment that primarily are used as guards for the airways.
Respirators are designed to protect the wearer from inhaling hazardous atmospheres, including fumes, vapours, gases, and particulate matter such as dust and airborne microorganisms.
Surgical masks are a personal protective equipment worn by health professionals during medical procedures. They prevent airborne transmission of infections by blocking the movement of pathogens (primarily bacteria and viruses) from the wearer's mouth and nose. They have become increasingly popular during the recent COVID-19 pandemic.
Other types are cloth face masks, made of common textiles, usually cotton, and worn over the mouth and nose when more effective masks are not available, and dust masks, which are flexible paper pads used for personal comfort during construction or cleaning activities.

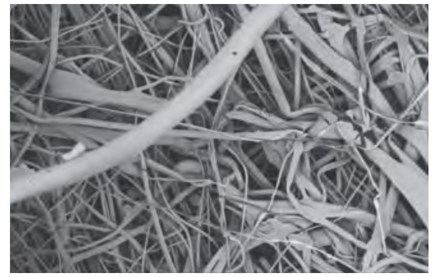


WHAT ARE FACE MASKS MADE OFF?

Respirators, also commonly known as N95 respirator masks, consist of multiple layers of nonwoven fabric, often made from polypropylene or polyester. The two outward protective layers of fabric, covering the inside and outside of the mask, are created using spun bonding. They act as a protection against the outside environment as well as a barrier to anything in the wearer's exhalations. Between the two spun bond layers there's a pre-filtration layer and the filtration layer. The pre-filtration layer is usually a needled nonwoven. The last layer is a high efficiency melt-blown nonwoven material, which determines the filtration efficiency.

Surgical masks, often recognizable by their blue color and adjustable nose clip, consist of 3 layers: a hydrophobic non-woven outer layer, a meltblown filter middle layer, and a soft absorbent non-woven inner layer. The SEM image on the left (courtesy of 4C Air) shows the 2 outward and inner layers.

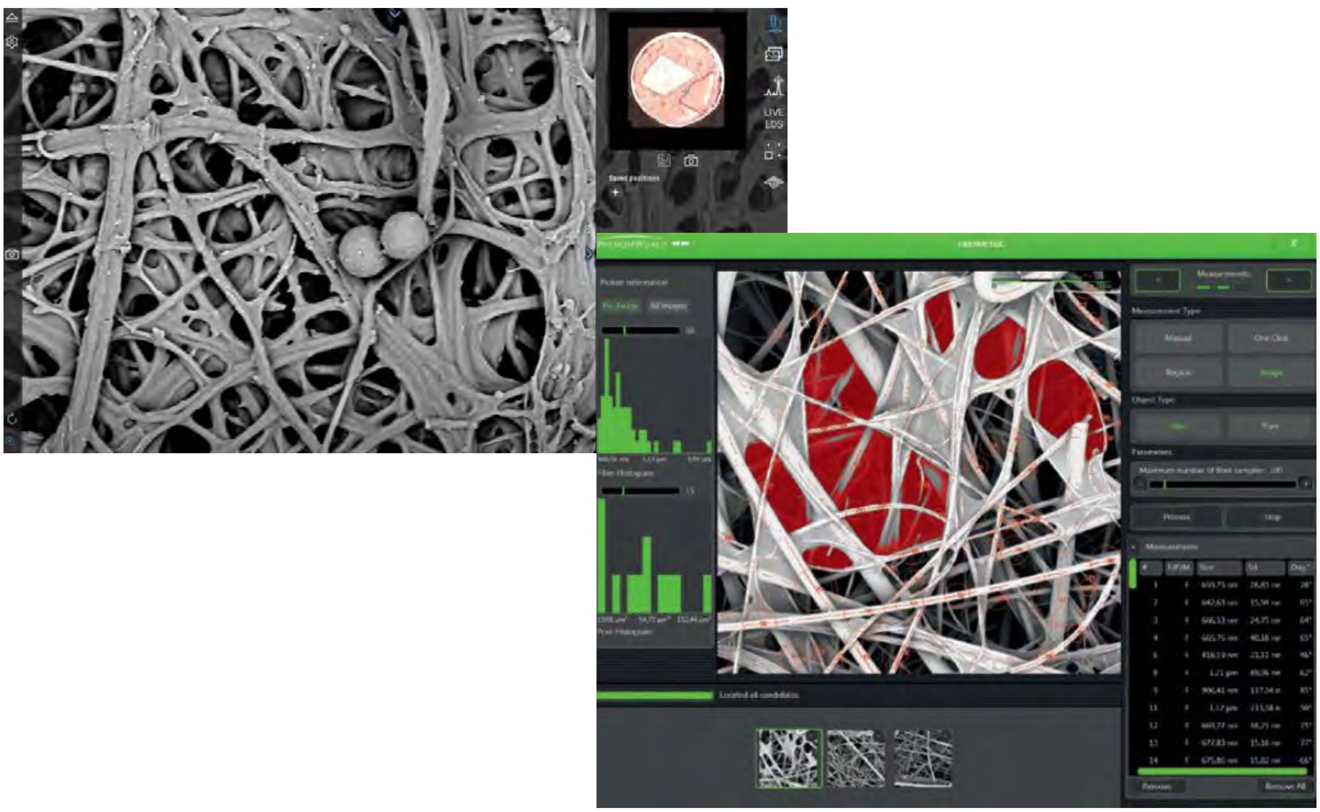
The material most used to make these masks is polypropylene. Blue surgical masks can also be made of polystyrene, polycarbonate, polyethylene, or polyester— all of which are types of fabrics derived from thermoplastic polymers. The SEM image on the right above shows a 10 nm gold coated non-woven polypropylene filtration layer at 1400x magnification. The SEM image on the right below shows a 10 nm gold coated detail of the polypropylene outer layer at 2900x magnification.



WHY IS SEM IMAGING USED TO STUDY FACE MASKS?

SEM imaging is an ideal tool to check the homogeneity, compactness and average diameter of fibers in the different face mask layers. The SEM image below on the left shows a 10 nm gold coated non-woven polypropylene filtration layer at 1400x maginification. Some SEM manufacturers have developed specific software applications for a fully automatic fiber diameter distribution measurement.

The pore size distribution and hence the filtration properties of the different layers can also be determined by specific software that measures the surface of the pores. The image below on the right shows how such an automated pore size distribution interface looks like. In that way SEM imaging is used to check the filter efficiency or combined with EDS chemical microanalysis techniques, to analyse the material that is captured on the filter.



Most polymers used in face masks are good thermal and electrical insulators. This means that when such materials, or the end products that are commercially developed from them, are scanned by the electron beam in a microscope, sample charging will often occur.
Such materials are called “beam sensitive”, which means they can easily deform or melt when scanned by an electron beam.

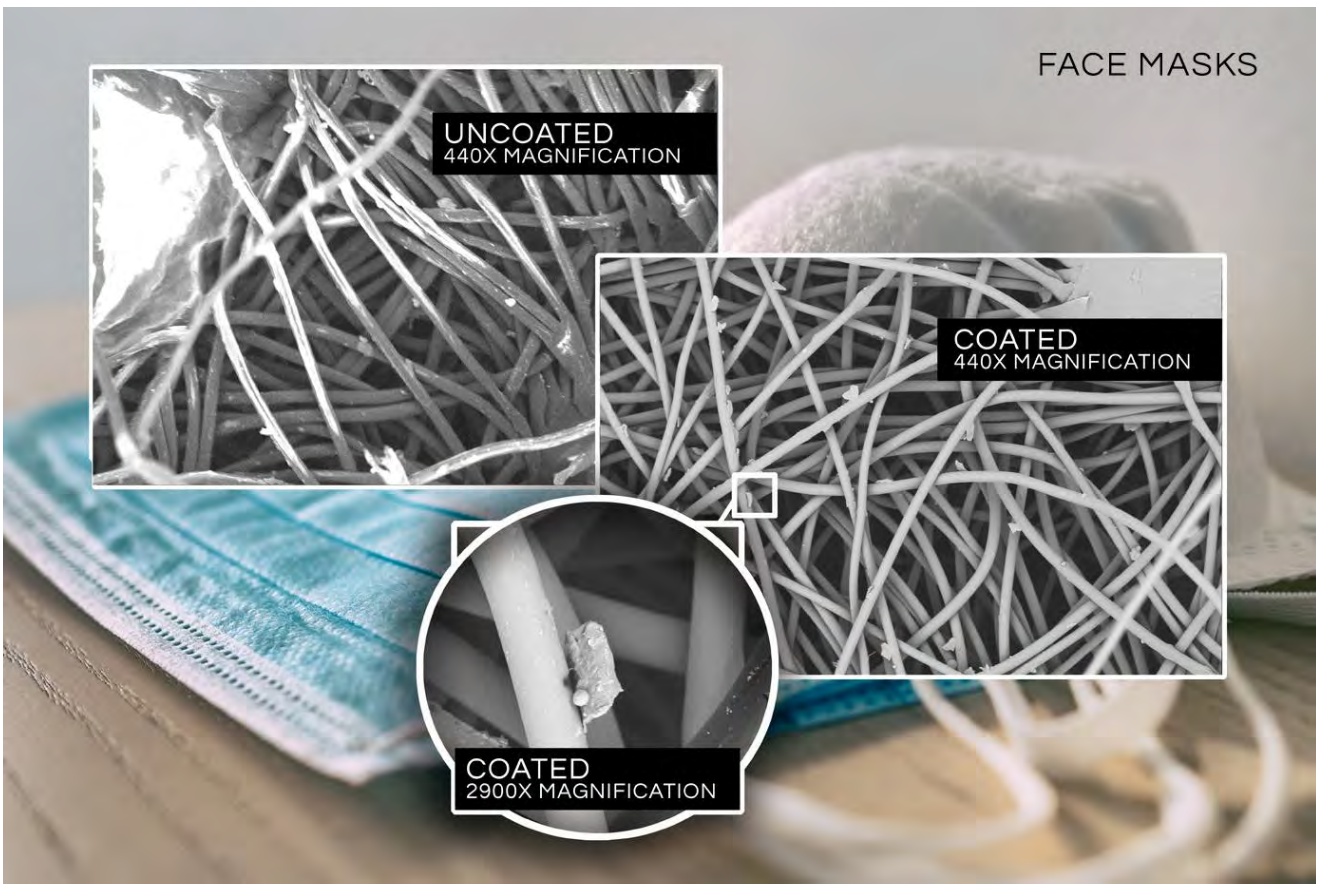
WHAT IS SAMPLE CHARGING?

What is sample charging and what are the effects of sample charging on SEM imaging, and what are the positive effects of metal sputter coating?

SEM images are generated by scanning an electron beam across the sample. This effectively adds electrons to the sample.Sample charging occurs when samples are bad electrical conductors which means there is no conducting path for electrons to flow from the sample surface towards the sample holder. Sample charging causes all kinds of problems such as drift, blur, and low contrast. In other words, blurry and false images.

By applying a very thin electrically conducting layer of metal such as gold or platinum (a process known as metal coating or sputter coating) onto the surface topography of the specimen, the electrons can flow from the sample surface towards the sample holder and sample charging is prevented. Other positive effects from sputter coating a sample are an improved secondary electron emission, a reduced beam penetration with improved edge resolution and a better protection of electron beam sensitive samples.

LUXOR metal coaters are designed to automatically apply a homogeneous and thin metal layer to your SEM samples, protecting them from any charging effects and enhancing the image resolution in your electron microscope.

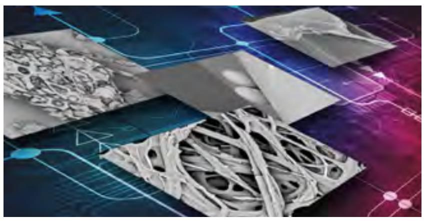


IMAGING AND COATING CONDITIONS

SEM images were recorded with a Thermo Scientific Phenom XL desktop electron microscope using the BS detector in high vacuum mode (1 Pa) at 10kV. A 10nm gold coating was applied using the LUXOR ^{Au} metal coater.

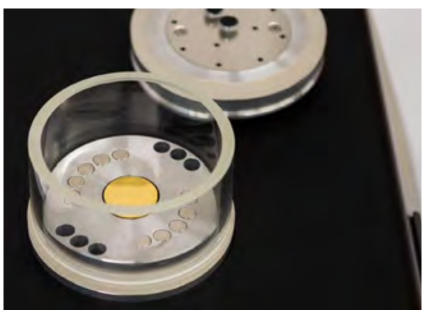
SPUTTER COATING WITH THE LUXOR METAL COATER

LUXOR metal coaters are used extensively in SEM and TEM labs worldwide where image quality and high resolution imaging are of the utmost importance. Metal sputter coating not only prevents sample charging, but also provides improved edge resolution and a better protection of electron beam sensitive samples. Even at relatively low magnifications sample coating offers additional security in a high throughput environment with multiple operators having to provide high quality images in a routine analysis environment on a large variety of samples.



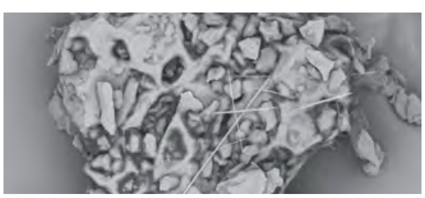
A² TECHNOLOGY

LUXOR's unique A² Technology generates a metal plasma and applies it in a controlled and accurate manner, resulting in an extremely uniform, thin and homogeneous metal layer. The unique way this process is controlled and adjusted is what distinguishes the LUXOR metal coaters from other commercially available instruments. For the SEM operator this means more homogeneous metal coatings, resulting in high resolution and high contrast images and a worry-free coating process without any manual intervention.



UPSIDE DOWN DESIGN

In the LUXOR metal coaters, the samples are mounted upside down. While this might seem a little controversial at first sight, it is actually a consequence of our 'form follows function' approach. In fact, the upside down architecture brings many advantages. First, all high voltage and high current wires are safely hidden within the instrument. This obviously greatly reduces the risk of electric hazards. Next, the sample loading station is easily accessible and allows to apply or remove the samples without the need for special tongs or tweezers. This doesn't just make everyday use easier, but also speeds up productivity. The upside design also makes sure that loose particles will be removed during the coating process. This way, your SEM is optimally protected.



FULL AUTOMATION

The coating process is fully automated. As soon as your samples are loaded into the preparation station, you only have to choose the desired coating thickness and push the start button. Thanks to this user friendly process, the chance of human errors is significantly reduced. Furthermore, this means that untrained operators and lab personnel can operate the device.

Distribution in the UK & Ireland

Lambda

Characterisation, Measurement & Analysis

Lambda Photometrics Limited
Lambda House Batford Mill
Harpenden Herts AL5 5BZ
United Kingdom
E: info@lambdaphoto.co.uk
W: www.lambdaphoto.co.uk
T: +44 (0)1582 764334
F: +44 (0)1582 712084