S1.1.1 - *Melt-Blown Media Manufacturing to Support the Global shortage of Mask Media used in PPE (Personal Protective Equipment)*

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With the onset of the coronavirus-2 or SARS-CoV-2 (COVID-19) since Dec 2019 there was a severe shortage of Personal Protective Equipment (PPE) as well as the melt-blown media that is used in these face masks and N95 respirators. Many commercially available face masks did not meet either the needed efficiency or the breathability requirements. Although Cummins Filtration works almost exclusively with high-temperature polymers like Polyester and Nylon, it was possible to leverage our technology to melt blow PolyPropylene (PP) and manufacture media with a high-Quality Factor (QF) as needed for ASTM Level 2 approved surgical face masks and NIOSH N95 respirators. Meltblowing PP with fine fibers allowed the development of a media with the high porosity needed to maintain low restriction or high breathability of face masks. While this was achieved.; the efficiency of the media was initially low, aided by mechanical filtration only; and needed to be improved to meet the critical particle capture requirement. The literature is well established on the means of enhancing the efficiency of air filtration media to create charged media called ‘electret’. Charging the polymers can be done by different methods such as hydroelectric charging, triboelectric charging, and electrostatic charging, or a combination. Expertise from Dr. Peter Tsai and collaboration from Oakridge labs aided

Cummins Filtration in the ability to incorporate ‘corona charging’ – an effective, safe, economical, and quickly realized charging method for the mask media manufacturing process. Corona charging uses an electric field that occurs when high voltage is applied between asymmetric electrodes. A surface charge is imparted on the fibers when passing through the corona field and is a function of the polarity and other parameters such as applied voltage/current, distance from the target, the weight of media, etc. Literature also gives details on the charge trapping mechanisms of corona charging. Once the surface charge is present, there are commercial methods that measure surface potential to make sure charging is optimal. Penetration (1-efficiency) of the media is also an effective method. Penetration was measured using neutralized aerosolized NaCl salt of 76nm using a TSI penetrometer at 5.3 cm/s face velocity. Electret filters rely heavily on charge for high efficiencies and there are studies that indicate that factors like temperature and humidity can accelerate the surface charge decay and cause significant reductions in efficiencies reducing it to almost uncharged levels. This was mitigated by adding Charge Enhancer Additives to maintain the stability of the surface charge for a longer duration of time and help with media shelf life. Charge Enhancer Additives require some minor processing changes in order to maintain fiber morphology as visualized using Scanning Electron Microscopy (SEM). These additives impact the thermoplastic behavior by shifting the glass transition temperature of the polymer and thereby making the polymer mixture more stable over a wider temperature range. Materials with higher dielectric constant (εr) and higher wettability can lose charge quickly and polypropylene which has a low dielectric and wettability compared to other polymers is best suited for electret media. Although the electret filters are here to stay, some applications may necessitate finding alternates that rely more on finer fiber technology such as the use of nanofibers to get high and long-lasting efficiencies. Nanofiber capabilities were used to produce media for respirators that perform at required levels without relying on charging. This Covid19 pandemic created a world-wide need for increased use of nonwovens in PPE at an extremely rapid pace and Cummins Filtration was fortunate to use existing technology to aid in these efforts but there is still room for the development of new technologies to help support the effort to stop the spread of COVID-19.

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Alfiya Ansar joined Cummins Filtration in 2016 and currently works as Media and Materials Technical Specialist. Alfiya has worked in Australia and United States; and has a varying degree of professional and academic experience in the fields of Biochemistry and Business Administration. Alfiya leverages her diverse background to drive improvements in the filtration media technology that continue to create value for our customers and strengthen our relationships. Cummins cares about making the world a better place with their products and leading the technical lane on projects like ‘Mask Media Manufacturing’ has allowed her to do just that.

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