

Figure 4

NH₃/50% RH (14°C Dew Point)

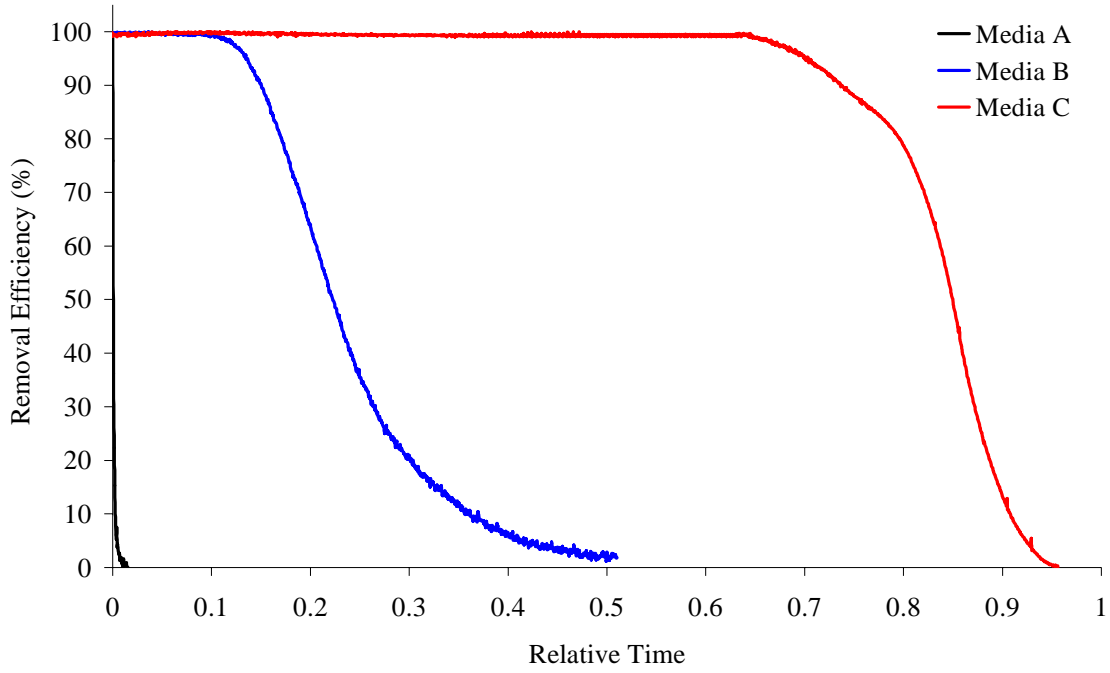
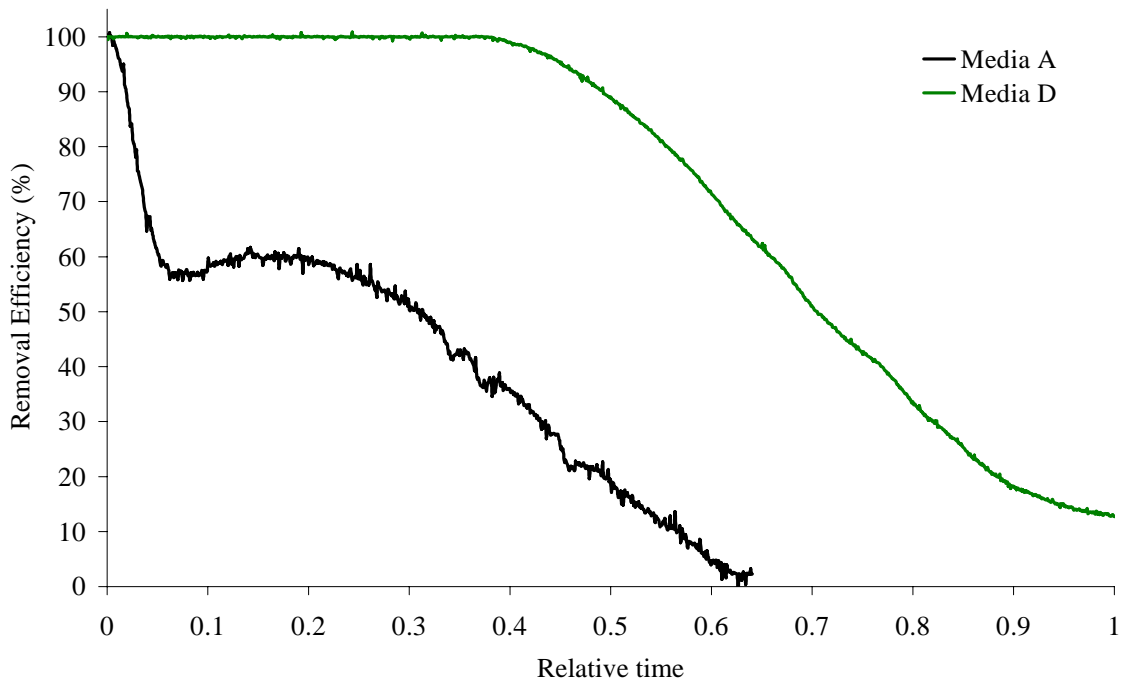
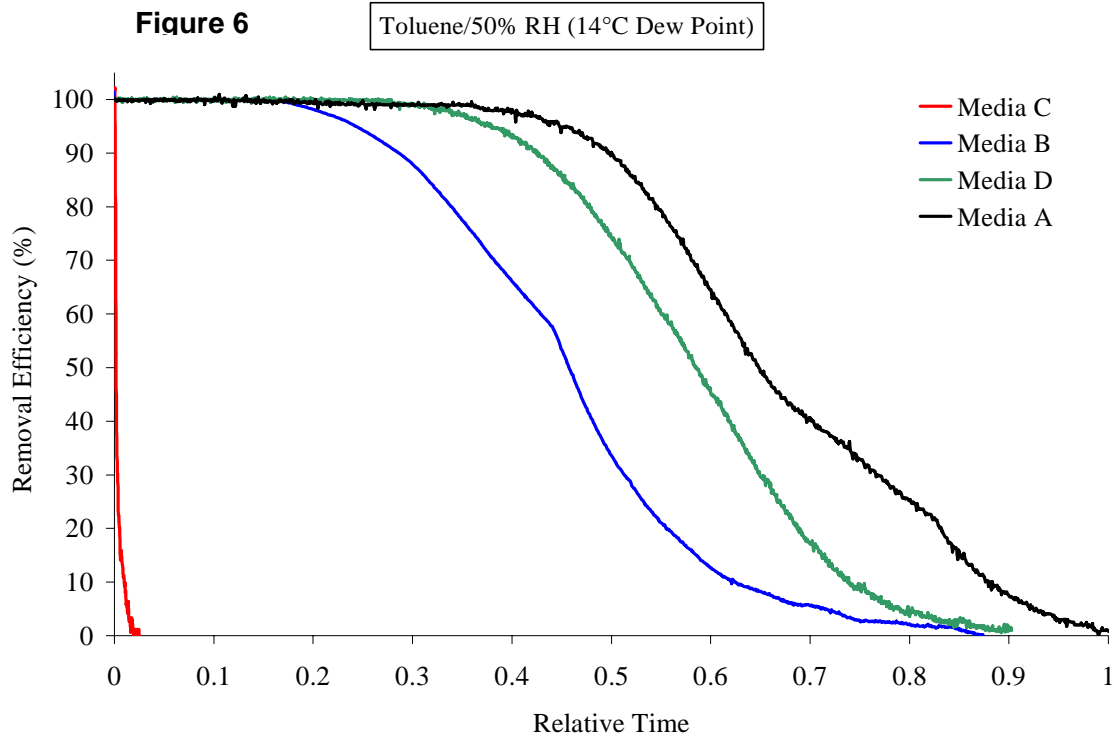


Figure 5

SO₂/50% RH (14°C Dew Point)





At both 0% RH and 50% RH the best performing media are Media C for basic contaminants, Media D for acidic contaminants, and Media A for organic contaminants. These three media maintain greater than 99% removal efficiencies for periods of time that meet, or exceed, the tool manufacturer's current requirements.

As a result of considering such a large range in humidity, it is evident that the presence, or absence, of moisture has a significant impact on the performance of these media. For some media the presence of moisture adversely affects its performance, whereas for others it enhances its performance. These effects can easily be observed in the series of filter efficiency curves presented below (figures 7-9) as a function of dew point. Over the dew point range of 21°C to -73°C, the removal efficiency life of Media B for basic contaminants drops by approximately 80 %, but it only drops by approximately 30% for Media C. For acidic contaminants over the same humidity range, the removal efficiency life of Media D drops by approximately 75%, but Media A is unaffected. Conversely, for the removal of organic contaminants over the dew point range of 14°C to -73°C, the removal efficiency life of Media A and D increase by approximately 57% and 65%, respectively.

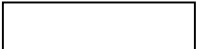


Figure 7: Effect of Dew Point on Chemical Filter Media Removal Efficiency

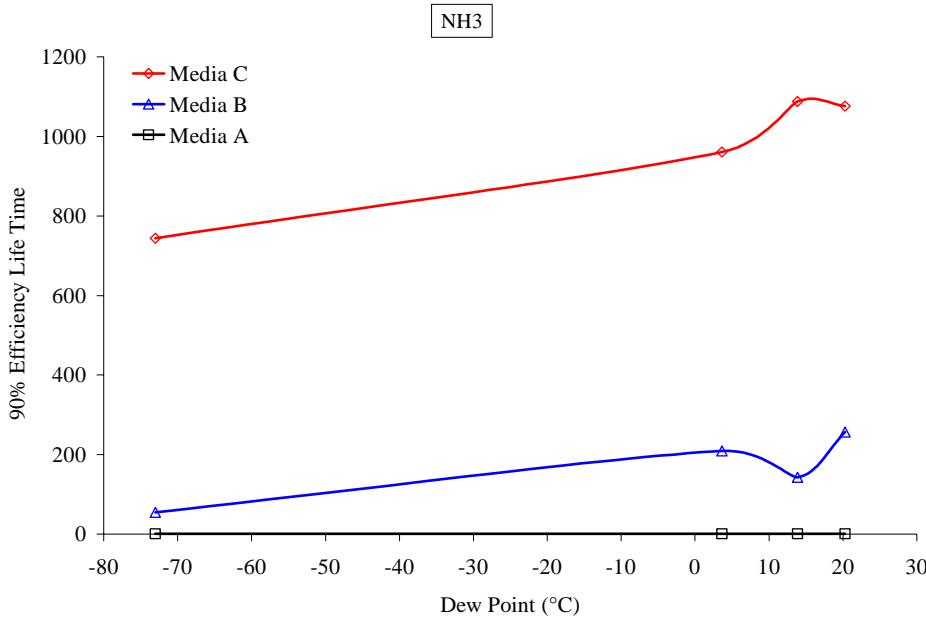


Figure 8

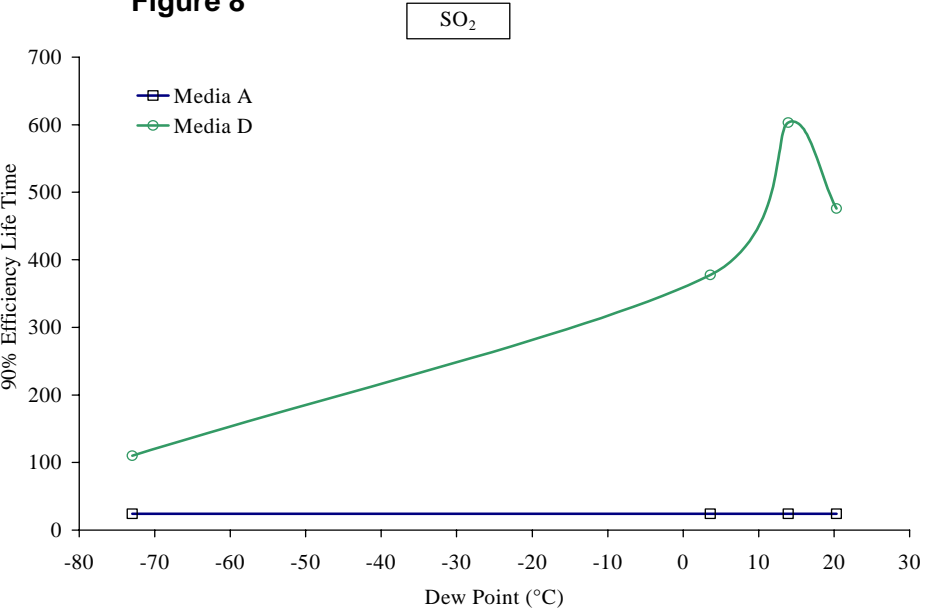
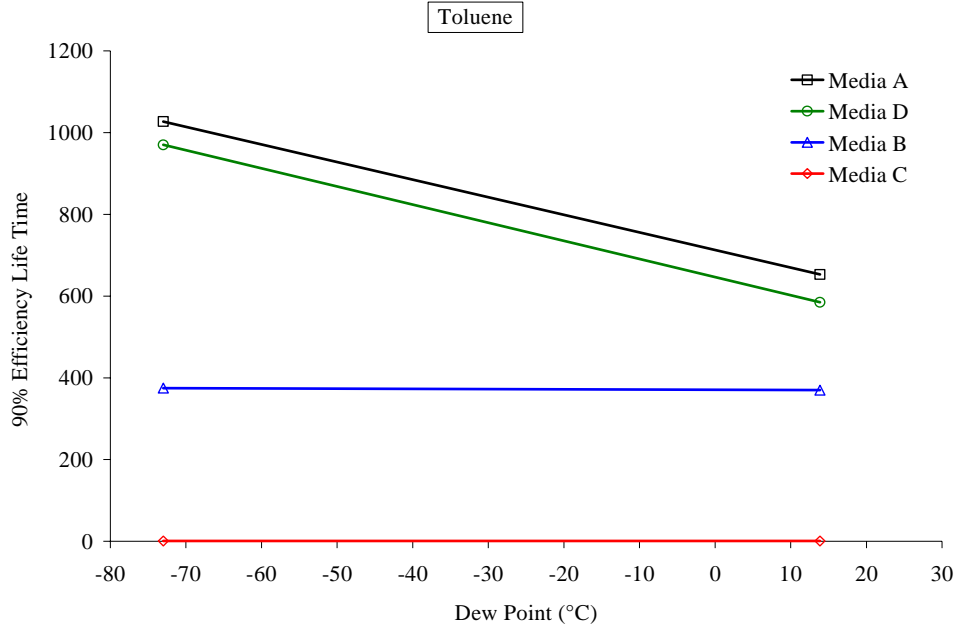


Figure 9



SUMMARY

Minor changes in environmental conditions (e.g. humidity) have shown to significantly affect the performance of filter media. Consequently, various point-of-use (POU) designs were considered for specific filter designs. Two prototype POU filters were developed using the test results of this work as a guideline to meet the critical environment requirements within an exposure tool. These prototype filters were designed to effectively remove basic, acidic, and organic airborne contaminants at the wafer and reticle stages, as well as in the illuminator system. In addition to the media performance results, actual exposure tool requirements for construction material off-gassing, size restrictions, pressure drop and flow rates were considered in designing these filters. The filter life estimates at 0% RH and 50% RH for known exposure tool challenge contaminant concentrations are given in the two tables below. As intentionally designed, the table summary shows that base contaminants breakthrough first, possibly resulting in "T-Topping." Although undesirable, such an event may be considered an inexpensive "end of filter life indicator" when compared to the costs associated with repairing damaged optical elements following organic and acid contamination exposure. A more desirable filter change out method is to generate a preventative maintenance schedule, drawn up in accordance with filter life estimation models using validated fab ambient conditions and filter media performance results.

Prototype Filter Life Estimates for NH₃, SO₂, & Organics When RH 0%

Challenge Contaminant	Challenge Concentration. (ppb)	Filter Life Estimate (years)	Estimated Filter Efficiency (%)
Base* 100		2.18	>99
Acid* 5		>4	>99
Organic* 100		9.01	>99

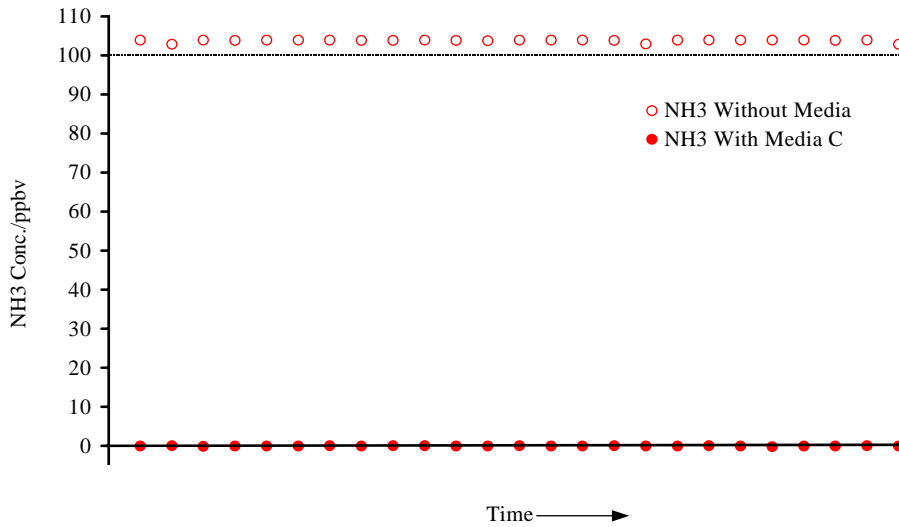
* **Challenge compounds: Bases = NH₃, Acids = SO₂ & Organics = Toluene**

Table : Prototype Filter Life Estimates for NH₃, SO₂, & Organics When RH 50%

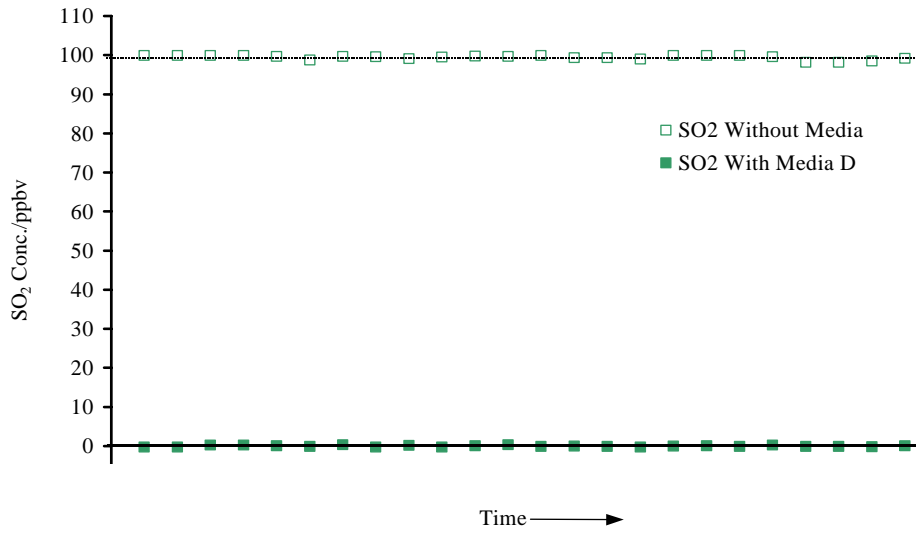
Challenge Contaminant	Challenge Concentration. (ppb)	Filter Life Estimate (years)	Estimated Filter Efficiency (%)
Base* 100		2.49	>99
Acid* 5		>4	>99
Organic* 100		4.56	>99

* **Challenge compounds: Bases = NH₃, Acids = SO₂ & Organics = Toluene**

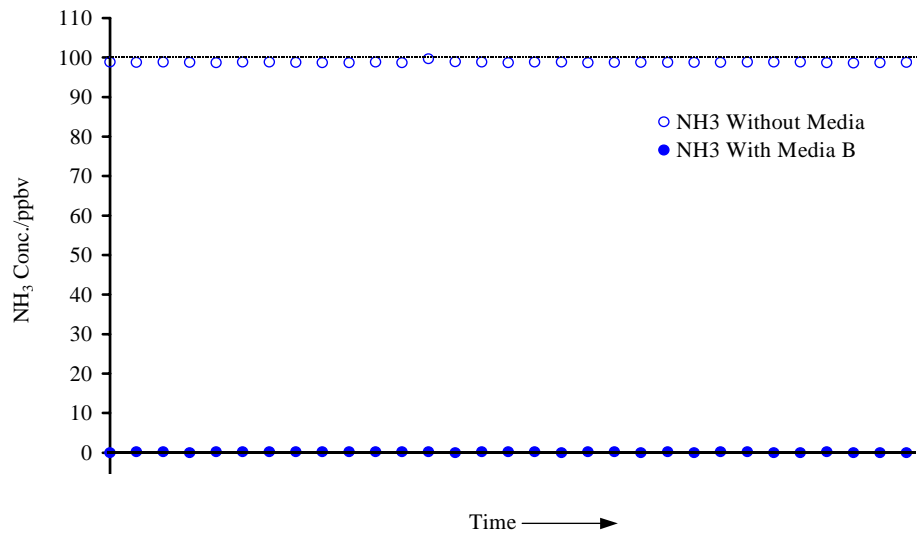
Removal Efficiency at 0% RH



Removal Efficiency at 0% RH



Removal Efficiency at 50% RH



Removal Efficiency at 50% RH

