In the microelectronics and pharmaceutical industries especially, particles microns in size and even smaller diminish the quality and quantity of the products produced. To reduce losses due to contamination, we need to detect particles in air, in other gases, and in liquids, as well as on surfaces. Various methods are discussed here. The methods using the scattering of light predominate currently.

INTRODUCTION

Contamination control is a mixture of high technology and low technology. Solving today’s problems often means making a painstaking survey of current procedures and contamination levels and resorting to increased care in dealing with people, equipment and materials. Solving tomorrow’s problems will require all that, along with greatly improved methods of detecting and quantifying contaminant particles.

Most yield loss in the microelectronics industry today is due to contamination. More than half the defects on wafers are due to particulate matter. The products being planned for the future will be even more sensitive than current products, so that by the next decade this industry will be concerned with the impact of particles approaching 0.01μm in size. An introduction to the particulate contamination in the microelectronics industry is available in Ref. 2.

Figure 1 shows the kind of problems that particles pose: they can cause short circuits between lines or layers that are conductive and they can cause disruption of current flow in conductive lines. They may do this by their continuing physical presence or by their having been present during the various lithography steps involved in the processing of the micro-circuits. Currently, such circuits have features microns in dimension and even smaller.

Figure 2 shows two widely-used relationships to predict yield: a simple exponential distribution and Murphy’s Law. For more advanced yield models, see Ref. 4. In Figure 2, yield is plotted versus the mean number of particles, AD, of the critical size (or larger) expected in the critical area A. D is defect density, in units such as particles per cm².
Figure 1. Schematic of "opens" and "shorts" in insulators and conductors in a microelectronic circuit element.

Figure 2. Exponential and Murphy's Law distribution models of yield versus expected number of defects, AD.