

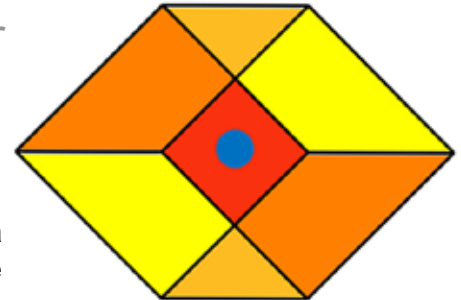


Molded Part Defect Identification

Scanning Electron Microscopy (SEM) is ideal for determining the presence of inorganic species.

The Challenge

Polymer Solutions received a molded silicone part that contained a small discoloration on the tip. Our client needed to understand the composition of the defect, in order to determine how it got there.

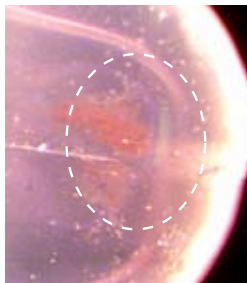


The Approach

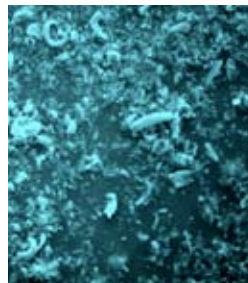
To solve this challenge, Polymer Solutions used three analytical techniques to examine and characterize the defect:

- Optical Microscopy (OM)
- Scanning electron microscopy (SEM)
- Energy Dispersive Spectroscopy (EDS)

Initially, the defect was viewed and documented using an optical microscope. In order to further characterize the defect region, SEM with EDS was also utilized. These two analytical techniques are ideal for determining the presence of inorganic materials, especially in a very small area. SEM magnifies the region of interest, while EDS acquires spectra of the chemical elements present in the magnified section. Using EDS, one can also create a visual map of the chemical elements that are present. The map portrays the location and concentration of each chemical element.



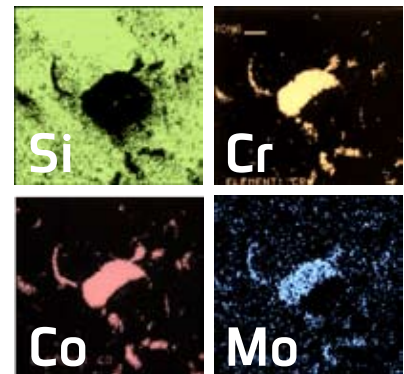
Optical 32x



SEM 500x



SEM 2,000x



SEM-EDS 2,000x

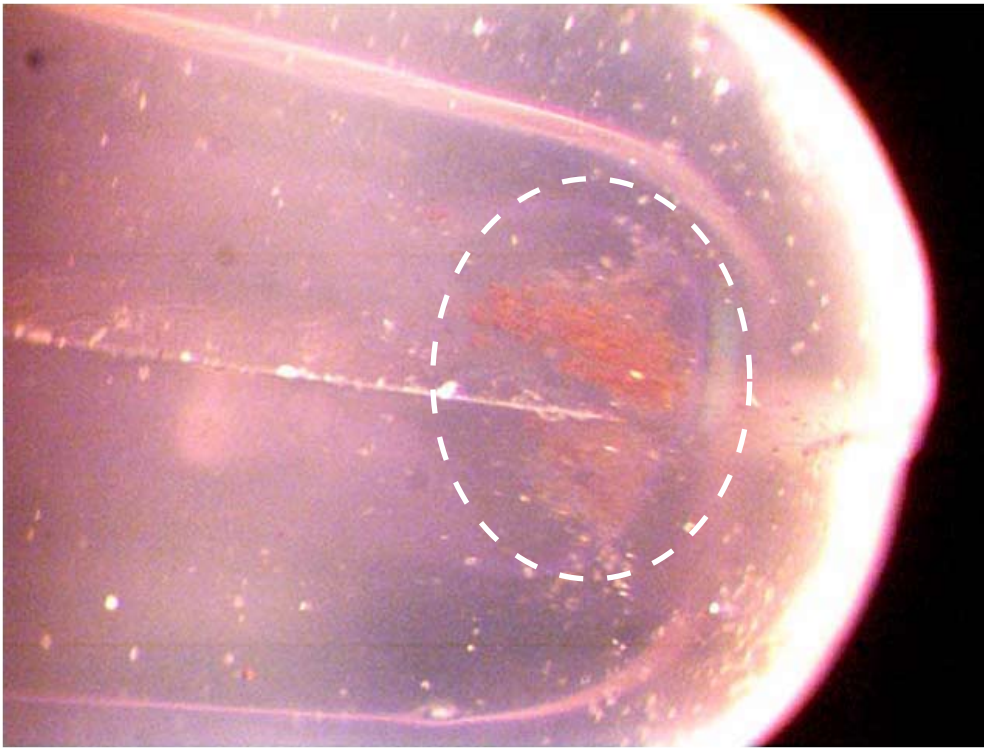


Figure 1: Optical micrograph (32x) of the defect region of the silicone part.

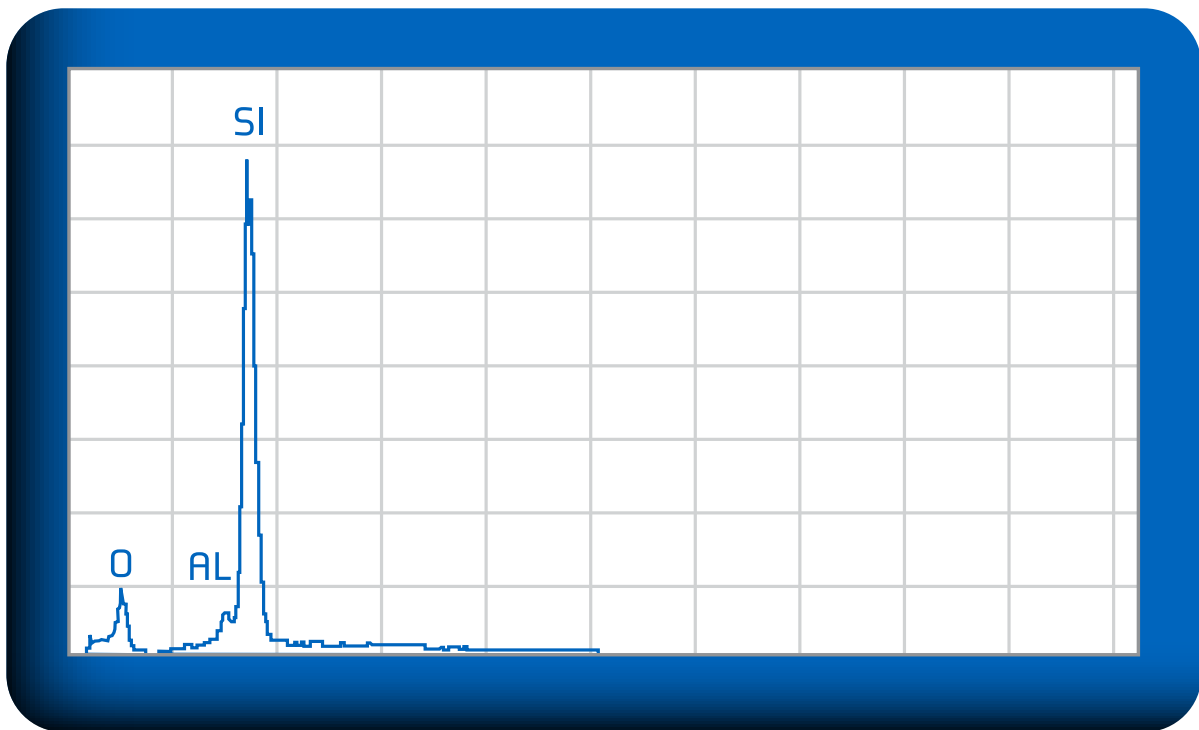


Figure 2: EDS spectrum of a reference region of the silicone part.

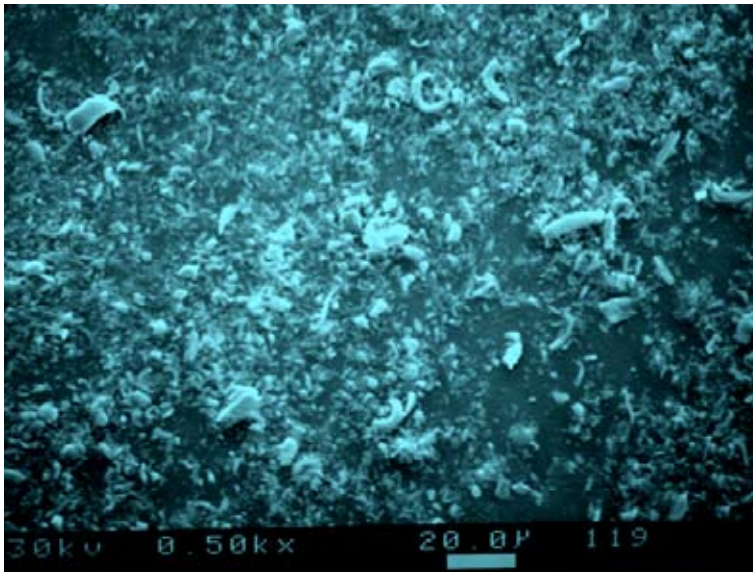


Figure 3: SEM micrograph (500x) of the defect region.

The defect region was then viewed using SEM (Figure 3). Many small particles were embedded in the surface of the silicone. Wide scan EDS analysis of the defect region revealed the presence of silicon, oxygen, aluminum, cobalt, chromium, and molybdenum (Figure 4).

Next, one of the particles in the defect region was isolated for spot mode analysis. Spot mode EDS analysis provides a spectrum of a specific spot on a defect particle. High concentrations of cobalt, chromium, and molybdenum were detected (Figure 5), compared to the wide scan (Figure 4).

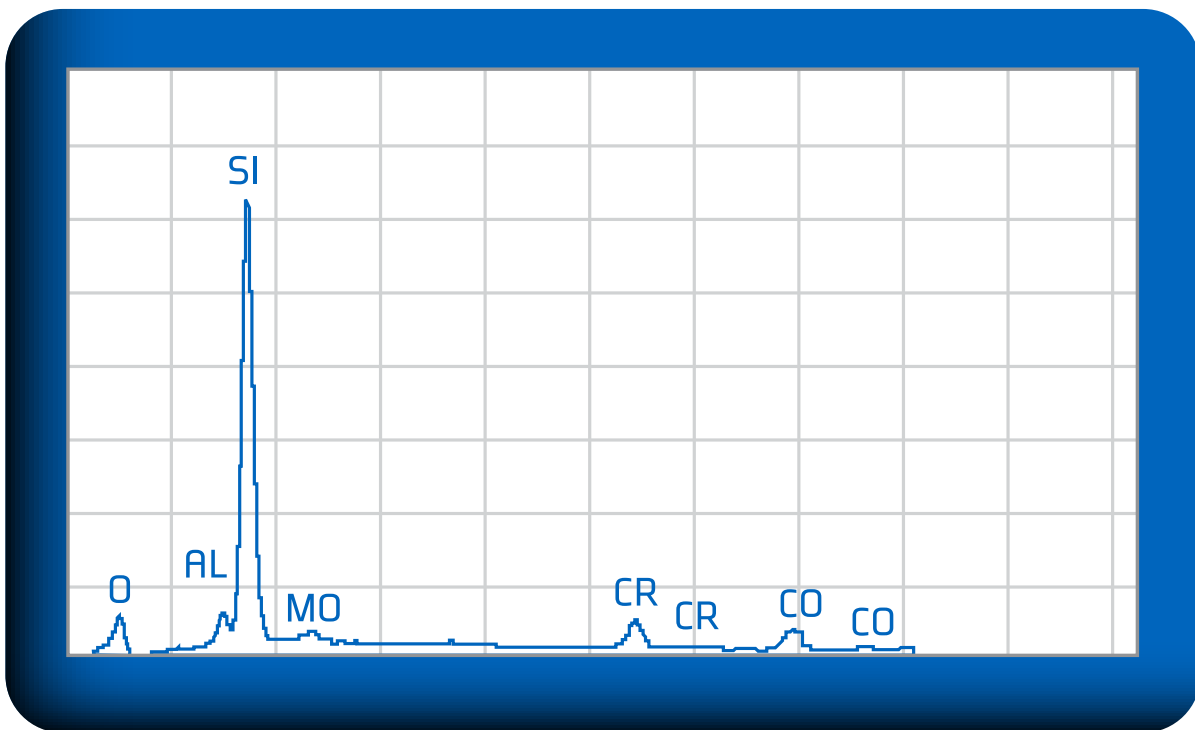


Figure 4: EDS spectrum of the defect region (wide scan).

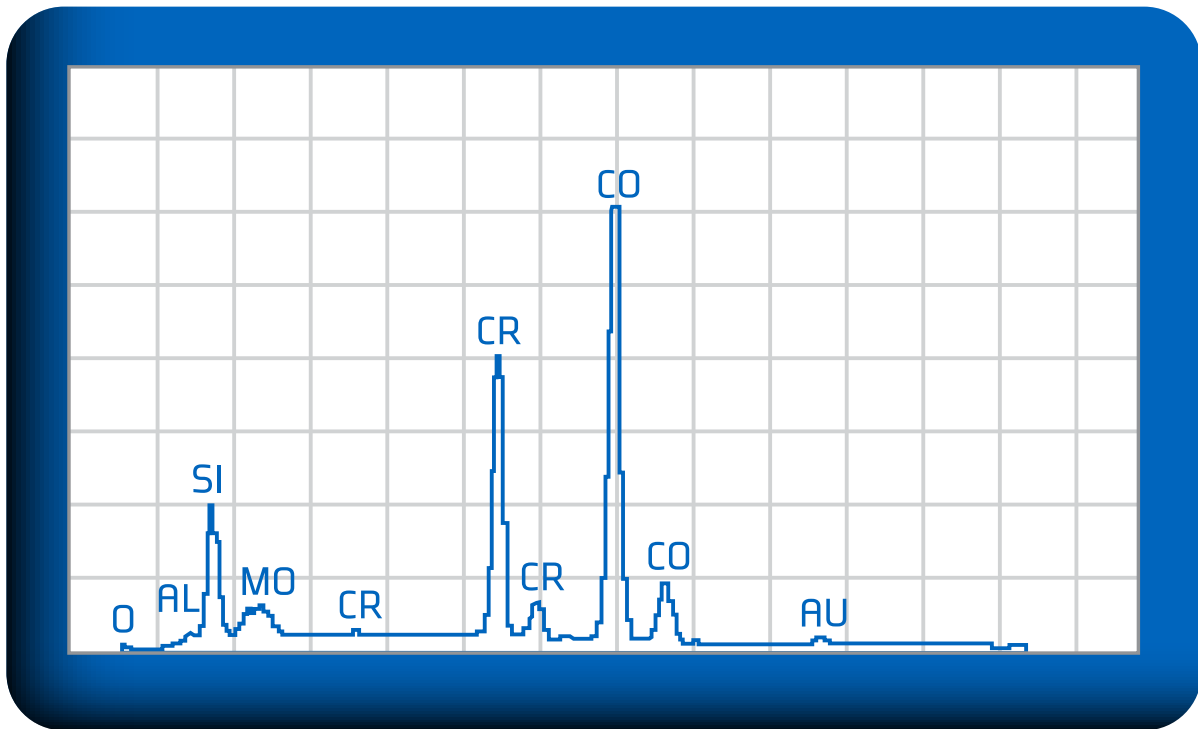


Figure 5: EDS analysis of a defect particle (spot mode).

In order to illustrate the spatial distribution of the elements in the defect region, elemental maps of the defect were acquired (Figure 6). The elemental maps (Figure 7) illustrate the spatial position of the chemical elements that were detected, and relate directly to the SEM micrograph that was obtained prior to mapping (Figure 6).

The maps show that the particle in Figure 6 is composed of cobalt, chromium, and molybdenum, and is embedded in a silicone matrix. The distribution of these three metals in the particle was consistent with an alloy of cobalt, chromium, and molybdenum. Table 1 lists the atomic concentrations of each chemical element that was detected in the reference region and in the specific defect particle.

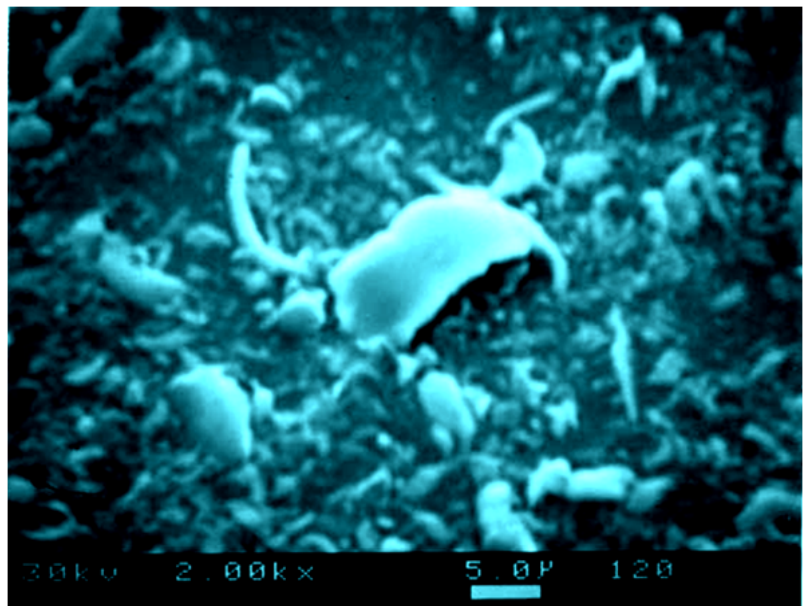


Figure 6: SEM micrograph (2,000x) of the defect particle.

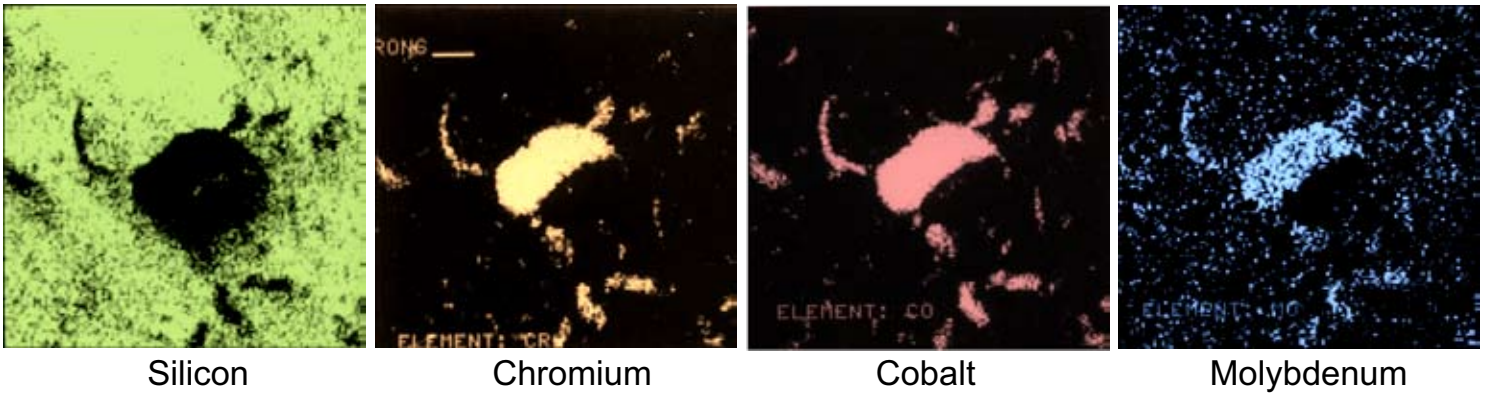


Figure 7: Elements detected in regions corresponding to Figure 6.

Element Detected	Reference Spectrum	Defect Particle Spot Mode
Silicon	30.66	25.68
Oxygen	66.36	0.76
Aluminum	2.99	2.29
Cobalt	*ND	45.22
Chromium	*ND	20.44
Molybdenum	*ND	5.6

*ND = Not Detected

Table 1: Atomic Concentrations (%) of Elements Detected.

Conclusions

Our testing showed that the defect was an alloy of cobalt, chromium, and molybdenum, embedded in the silicone matrix. This alloy was present in another process within the same manufacturing facility, and was found to be the contaminant in the silicone part.

Relish the Challenge. Then Solve It.