Silicon Loss in Breast Implants

Student's Name

Institutional Affiliation

Silicon Loss in Breast Implants

Breast enhancement and reconstruction following a mastectomy have increased at a considerable rate in the last four decades. In 2018, approximately 310,000 females in the United States used surgical treatment characterized by a silicone implant. However, at the same time, the previous year recorded about 41,000 implant removal implants, including augmentation and reconstruction. In the Netherlands, it is estimated that approximately 20,000 – 30,000 Dutch females take part in implant treatment every year despite the growing controversies on the safety of the procedures that take place. These controversies arise from the possible rupturing of silicone breast implants, especially in conditions where it may go undetected for a few years.

Silicon loss results from a series of experiments on different parts of silicone breast implants including the shell, gel, and tube. Nitric acid acidification on some of the samples was done for safety purposes to minimize hazardous vapor that may be produced during the experiment. Based on the involvement of nitric acid in most of the samples, the subsequent paragraphs detail various factors including the weight loss of the samples due to the conditions they are exposed to, as well as presenting the mass spectrometric measurements.

Measurement of the Mass Spectrometric Factors

Fundamentally, three basic silicone isotopes could be presented in all the samples collected. These include 28Si, 29Si, and 30Si respectively, according to the isotopes they are interacted with. For instance, $^{14}N_2^+$ and $^{12}C^{16}O^+$ at m/z 28, $^{14}N^{15}N^+$ and $^{13}C^{16}O^+$ at m/z 29, as well as $^{14}N^{16}O^+$ at m/z 30. The nominal abundance of each of the isotopes is categorized as 92.23 percent, 4.67 percent, and 3.01 percent, respectively (Sugama et al., 2015). In that regard, it is not possible to resolve the isobaric interference of each isotope using the ICP-MS quadrupole technology adopted for this study or research. This is due to the fact that while $^{14}N_2^+$ demonstrated a positive interference or resolution for silicon at mass unit 28, for m/z 29,

the background analysis was based on an order of magnitude lower than that of ^{28}Si. The lower natural abundance of the ^{29}Si, therefore, resulted in a low ppb silicon, which is categorized as twice the background signal. The natural abundance of m/z 28 silicon is stated to be ten times its background signal. For ^{30}Si, the signal was determined to be high. That calibration was indiscernible as is reflected by the ICP-MS outputs for all the samples depending on the area they were retrieved from – in other words, whether from the shell, gel, or tube.

Weight Change Measurement and $SiOH_2$

The silicone breast implant samples showed the reduction as well as increase in weight based on the formula presented below:

$$\%W = ((W_a - W_b) / Wb) * 100$$

Where W_a is the weight after the cycle and Wb the weight before the temperature cycle, respectively.

Based on the observable differences between the different conditions and their subjection to alternating temperature characteristics, the most substantial changes were realized in the acidic solutions or samples, and more so in those diffused in 1N HCL. The percentage weight changes were 0.5 percent, 0.61 percent, as well as 0.54 percent for the silicone shell, gel, and tube, respectively. The samples diffused in 0.1N HCL also demonstrated massive weight percentage changes. The samples exposed to water, on the other hand, did not change in weight as much as those subjected to acidic solutions, since silicone shells recorded a weight decrease of 0.28 percent in water.

In contrast, silicone gel reported a decrease in weight percentage of 0.33 percent. For the silicone tube, the percentage decrease in weight was 0.25 percent. It can also be observed that for the basic solutions, the percentage weight change (reductions) was minimal in 1N

NaOH solutions for all five samples in each category. It was, however, the most minimum in silicon samples exposed to 0.1N NaOH solution.

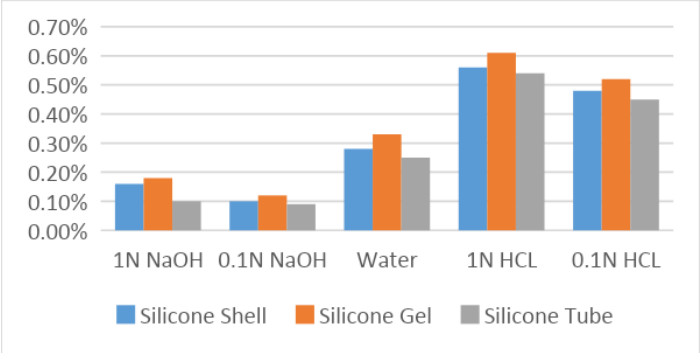

Figure 1: Weight Change after Temperature Cycling

For all the samples, as shown in Figure 1, the samples with the most percentage weight change with regards to the level of decrease were silicone gel. The percentage weight loss for the latter was based on the reference number published in Table 5, and their solution included 0.18 percent, 0.12 percent, 0.33 percent, 0.61 percent, as well as 0.52 percent. Silicone tubes recorded the lowest percentage changes compared to the shell and the gel itself as already mentioned, and this could be attributed to various reasons as well as the abundance of Si on them.

Fundamentally, when the samples were exposed to the various aqueous solutions, the polysiloxane backbone of both the silicone tube and shell swelled up and caused the SiO_2 ions to leach out, leading to the loss of weight for the primary samples. However, acidic conditions lead to the prolonged weakening of the polysiloxane backbone of the two, thus resulting in the most weight loss. Consequently, some of the SiO_2 or calcium carbides reacted with the acidic solution, contributing to the highest loss of weight for the various components. The silicone gel was, however, the most affected, since the SiO_2 particles were in kinematics or a constant state of motion, thus making them excited, and therefore highly reactive with the surrounding conditions. As earlier studies have reported, weight loss under these conditions is always attributed to the release of cyclic siloxanes, and the addition of

nitric acid accelerates the decomposition of the silicone tube as well as the shell (Feng et al., 2014). In summary, it could be stated that alternating temperatures and other environmental factors had a significant effect on the weight loss of the samples and specifically with the diffusion of SiO_2.

References

Feng, J., Zhang, Q., Tu, Z., Tu, W., Wan, Z., Pan, M., & Zhang, H. (2014). Degradation of silicone rubbers with different hardness in various aqueous solutions. *Polymer Degradation and Stability, 109*, 122-128. doi:10.1016/j.polymdegradstab.2014.07.011

Sugama, T., Pyatina, T., Redline, E., McElhanon, J., & Blankenship, D. (2015). Degradation of different ELASTOMERIC polymers in SIMULATED geothermal environments at 300 °C. *Polymer Degradation and Stability, 120*, 328-339. doi:10.1016/j.polymdegradstab.2015.07.010