UV-Vis Transmission and Haze Study of Silicone Fluids

Can B Hu, and Daniel Urbaniak
Abbott Medical Optics Inc., Santa Ana, CA 92705

Introduction: Silicone is a widely used biomaterial[1]. For ophthalmologic applications such as intraocular lenses (IOLs), clarity is a critical property. The clarity of freshly synthesized silicone fluids may not meet the visual clarity requirements for IOLs. High molecular weight silicone fluids with an elevated refractive index of 1.47 often exhibit unacceptable levels of haze. Although the cause and nature of haze is unclear, it was found that the desired clarity could be achieved by filtration. This paper evaluates the relationship between UV-Vis transmission and haze level of silicone fluid before and after filtration.

Material and Methods: Six batches of high molecular weight silicone, identified as lots 1 – 6, with refractive index of 1.47±0.01 were synthesized by anionic ring-opening polymerization[2,3]. The silicone was filtered using positive-pressure filtration through 0.2 µm PTFE filters at 80-90 psi. UV-Vis percent transmission (%T) spectra were recorded using a Beckman DU800 spectrophotometer. Haze measurements before and after filtrations were made using a Hunter Lab UltraScan Pro Color Measurement Spectrophotometer. Haze is defined as the ratio of diffuse light to the total light transmitted by a specimen[4].

Results: **Figure 1** shows the UV-Vis spectrum of a typical silicone fluid before and after filtration. The %T values increased as a result of filtration. The area between the two scans differed. The area for the six lots of silicone fluids was estimated by summing the %T difference over the wavelength range of 400 – 800 nm (in 0.5 nm steps). Area and normalized area values are summarized in **Table 1**.

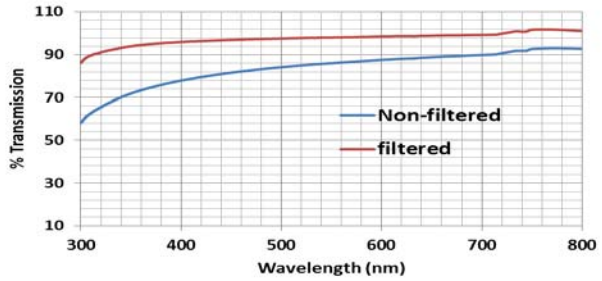

Figure 1.UV-Vis spectra before and after filtration

Lot	1	2	3	4	5	6
Area	2393	7663	2028	4710	2842	3380
Normalized*	1.18	3.78	1.00	2.32	1.40	1.67

Table 1. Area and normalized area (*normalized relative to lot 3)

The haze levels before and after filtration as well as the difference and normalized difference of haze level were summarized in **Table 2**. Improvement of haze level after filtration was clearly demonstrated by the reduction of haze level for all these six batches. Although the initial haze level was quite different from 6.4 to 28.9, these values were reduced to 1.4 to 4.8 after filtration. The difference of haze level was also normalized with the smallest value (Batch 3 in this case).

Lot	1	2	3	4	5	6
Haze (NF)	10.9	28.9	6.4	18.7	10.0	10.5
Haze (F)	4.8	2.0	1.4	4.8	2.3	1.4
Difference	6.1	26.9	5.0	13.9	7.7	9.4
Normalized	1.22	5.38	1.00	2.78	1.54	1.82

Table 2 Haze level before and after filtration

The UV/Vis area and haze level differences both show similar changes due to filtration. A plot of normalized area difference of UV-Vis transmission area and the normalized haze difference is shown in **Figure 2**. A linear relation between these two parameters was found.

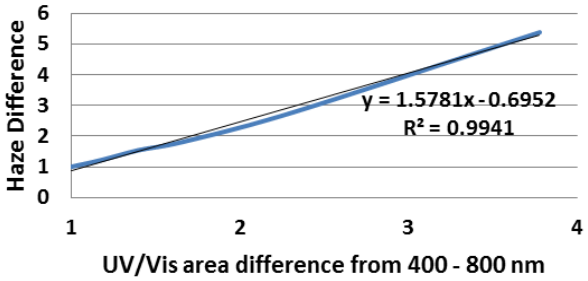

Figure 2. The relation between normalized %T area and haze

Conclusions: In this study, we found that filtration was a very effective method to improve the clarity of silicone fluid. We also found that UV-Vis transmission spectra and the haze level of high refractive index silicone fluids were related. Silicone fluids with difference in %T in UV-Vis spectra also showed similar magnitude difference of the haze level. The information obtained from UV-Vis spectra can also be used to predict the haze behavior of the silicone fluid.

References:

1.J. H. Son, C Kim and J. W Yang "Comparison of experimental porous silicone implants" Graefes Arch Clin Exp Ophthalmol 250 879-885 (2012).
2.A. R. Gilbert and S. W. Kantor "Transient Catalyst for the Polymerization of Organosiloxanes" J. Poly. Science XL. 35-58 (1959).
3.C. B. Hu, D. Pham, M. Lowery and R. Jain "Design of Silicone Materials for Ophthalmic Application", Soc. Biomat. 35th Ann. Mtg., 90 (2011).
4. ASTM D1003-00 "Standard Test Method for Haze and Luminous Transmittance of Transparent Plastics".