

Measurement of Polymeric Surface Modification in Central Venous Catheter Lumens

B. André Weinstock, PhD, Sr. Scientist

Analytical Lead, Semprus Biosciences Inc., Cambridge MA 02139



Figure 1. The Harrick VideoMVP.

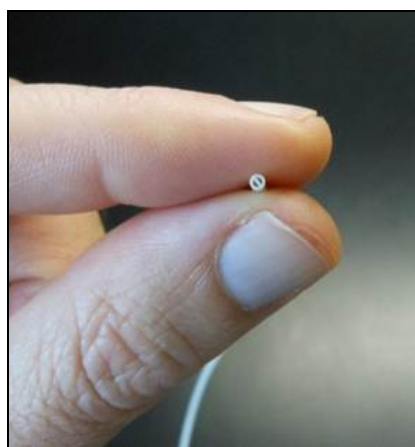


Figure 2. Cross-section of a 5 French dual lumen CVC showing the approximate size of the inside surfaces requiring consistent and precise ATR FT-IR.

INTRODUCTION

About 5 million patients require the use of central venous catheters (CVCs) annually in the United States¹. These devices are used for prolonged periods to deliver chemotherapy regimens, antibiotic therapy, and total parenteral nutrition; however, thrombosis and infection complications are common and associated with substantial morbidity and cost. In a study of cancer patients with CVCs about 41% required device removal before the end of treatment as a result of such complications². CVCs with their internal and external surfaces modified with a poly-sulfobetaine effectively reduced protein, blood cell, and microbial attachment in *in-vitro* and short term *in-vivo* studies³.

The primary analytical method of determining the presence of the polymeric sulfobetaine surface modification is attenuated total reflection Fourier transform infrared spectrometry (ATR FT-IR)^{3,4}.

Because the surfaces of the CVC, especially the inside lumen surfaces, can be $<1 \text{ mm}^2$ in surface area and possess complicated topographies, it was essential to have a small,

extremely durable ATR FT-IR internal reflection element (IRE) and the ability to see, in real time, the exact placement of samples on the IRE. The Harrick [VideoMVP](#) with a diamond IRE and $250\mu\text{m}$ diameter sampling area allowed for both these criteria to be readily met.

EXPERIMENTAL

Surface modified CVCs were sectioned by a defined protocol to give a statistical sampling of the device surfaces, both inside and out. Individual samples were placed on the VideoMVP and aligned to the desired surface sample site using the integrated video system. Consistent and complete contact between the sample and the diamond IRE were ensured by observing the video image and monitoring the applied force with the integrated force sensor. The spectrometer used a DTGS detector and was set at 4cm^{-1} resolution. 32 spectral co-adds were performed. The spectral window of 881.8cm^{-1} to 1845.6cm^{-1} was monitored using the algorithm described in Weinstock *et al.*⁴ providing an estimated thickness of the surface modification at each sample site.

Measurement of polymeric surface modification in central venous catheter lumens

RESULTS AND DISCUSSION

The estimated thickness of the Sustain surface modification on the CVC substrate was found to be between 500nm to 5000nm with a median thickness of ~1500nm. The precision of the thickness measurement was found to be ± 50 nm.

CONCLUSIONS

Use of the Harrick VideoMVP allowed for reproducible and rapid ATR FT-IR sampling of the various surfaces on a CVC. This allowed for production to set consistent boundaries for quality control and increase the rate of analysis throughput to approximately 30 minutes per CVC.

REFERENCES

1. I. Raad, "Intravascular-catheter-related infections." *Lancet* **351**, 893-898 (1998).
2. K. Cheong, D. Perry, C. Karapetis, B. Koczwara, "High rate of complications associated with peripherally inserted central venous catheters in patients with solid tumors." *Inter Med J* **34**, 234-238 (2004).
3. R. Smith, Z. Zhang, M. Bouchard, J. Li, H. Lapp, G. Brotske, D. Lucchino, D. Weaver, L. Roth, A. Coury, J. Biggerstaff, S. Sukavaneshvar, R. Langer, C. Loose. Vascular catheters with a nonleaching poly-sulfobetaine surface modification reduce thrombus formation and microbial attachment. *Sci Trans Med* **4**, 153ra132 (2012)
4. B. Weinstock, L. Guiney, C. Loose, Rapid nondestructive estimation of surface polymer layer thickness using attenuated total reflection Fourier transform infrared (ATR FT-IR) spectroscopy and synthetic spectra derived from optical principles. *Appl Spec* **66**, 1311-1319 (2012).

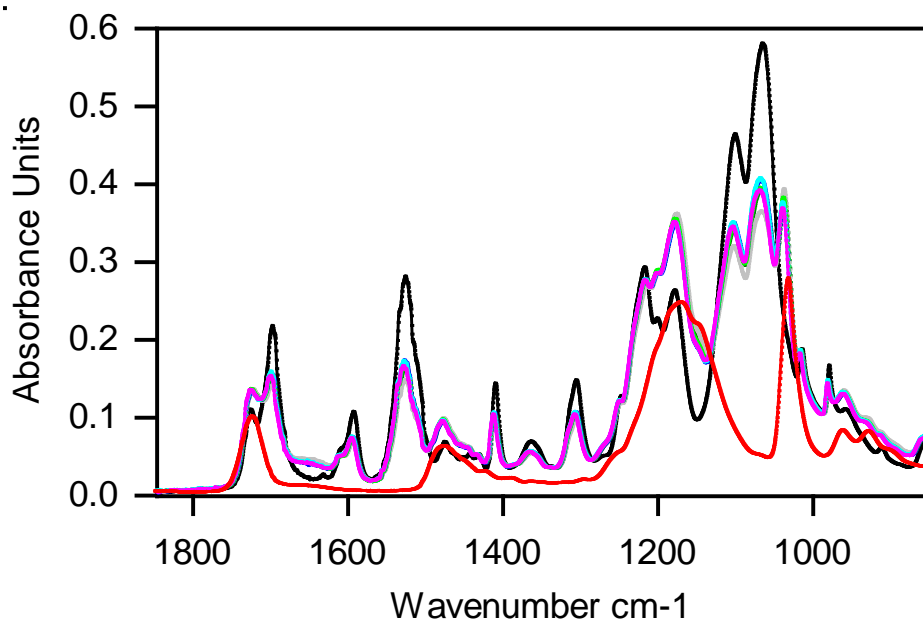


Figure 3. ATR FT-IR Absorbance spectra of CVC septa with various thicknesses (0nm to >10,000nm) of poly-sulfobetaine modification.



HARRICK SCIENTIFIC PRODUCTS

141 Tompkins Ave., 2nd floor • PO Box 277 • Pleasantville, NY 10570

www.harricksci.com • E-mail: info@harricksci.com

Phone (international): 914-747-7202 • Phone (in USA): 800-248-3847 • Fax: 914-747-7209