Comparative Evaluation of Etnom® and Membrix RF® Thin Film Sample Supports for X-Ray Fluorescence Analysis

Chemical Resistance, Impurity Analysis, and X-ray Transmission Performance

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1. Introduction

Thin film windows play a critical role in X-ray fluorescence (XRF) sample preparation, serving as the physical barrier between the liquid or solid analyte and the instrument optics while allowing X-ray photons to pass with minimal attenuation. The choice of film material directly affects measurement accuracy, chemical compatibility with the sample matrix, and detection sensitivity for low-atomic-number (low-Z) elements. Films that introduce elemental impurities, degrade in contact with solvents, or exhibit excessive X-ray absorption can substantially compromise analytical performance. This application note compares Membrix RF® (3.0 µm) film against Etnom® (3.0 µm) film across three key performance areas: transmission efficiency, X-ray elemental impurity profile, and chemical resistance, providing guidance for film selection in routine and trace-level XRF analysis.

Measurements were performed using a Rigaku WD-XRF Supermini200 (SM200) 200 watt system equipped with a Pd X-ray tube. *These ASTM methods are only representative applications in which thin film sample supports are commonly used.

2. X-Ray Transmission Performance

X-ray transmission through the film window is a fundamental parameter governing instrument sensitivity for light elements. Higher mass-thickness or heavier elemental polymer composition of the film increases attenuation of low-energy fluorescence photons, reducing net count rates and elevating detection limits. The sulfur Kα line (S-Kα, 2.308 keV) was selected as the transmission benchmark, given its direct relevance to regulatory trace-sulfur analysis in petroleum products (e.g., ASTM D7039, D4294, D6445, D2622, etc.). To ensure a reliable comparison, a sulfur-containing reference material, taurine, (an amino sulfonic acid) was used in a pressed pellet of micro crystalline cellulose. Results are shown in Figure 1 and intensities listed in Table 1.

Film	S-Kα Intensity (kcps)	Relative Transmission (%)
No Film	17.8491	100%
Membrix RF® Film	14.3826	80.57%
Etnom® Film	14.3905	80.62%

Table 1. *S-Kα line transmission loss for each film relative to open-beam (no film) reference measurement.*

Excessive transmission loss at the S-Kα energy directly reduces the net signal count rate for sulfur, degrading the method limit of detection (LOD) and increasing measurement uncertainty — a critical concern for ultra-low sulfur specification testing in diesel and gasoline, where regulatory thresholds can be as low as 10 mg/kg (10 ppm).

Figure 1 — Comparative XRF Transmission Performance

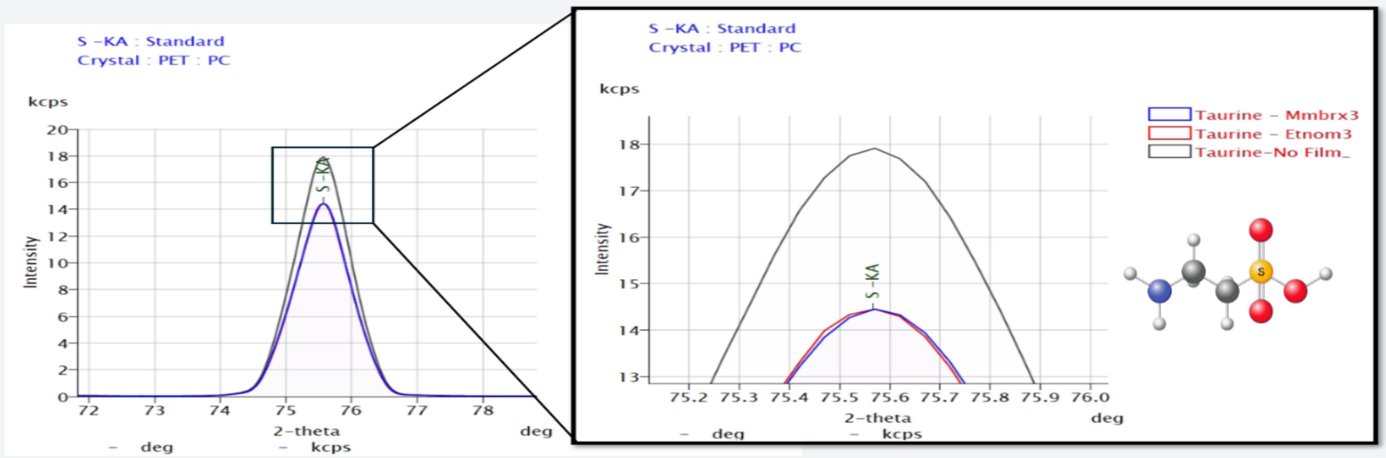

Figure 1. *Comparative XRF transmission performance and efficiency of Membrix RF® film (blue line) and Etnom® film (red line) against a taurine (a sulfur reference) pressed pellet. The spectra exhibit comparable transmission of S-Kα at 2.308 keV for both Membrix RF® and Etnom® films.*

3. Impurity Analysis

Elemental impurities within the film material can produce spectral interferences that artificially elevate background counts or overlap with analyte XRF lines, introducing systematic bias into quantitative results. Both films were analyzed directly by XRF to characterize their intrinsic elemental content.

Film	Detected Impurities
Membrix RF® Film	Si, P
Etnom® Film	Si, P

Table 2*. Elemental impurities detected by direct XRF analysis of Membrix RF® and Etnom® film materials.*

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Figure 2 —Elemental Impurity Comparison

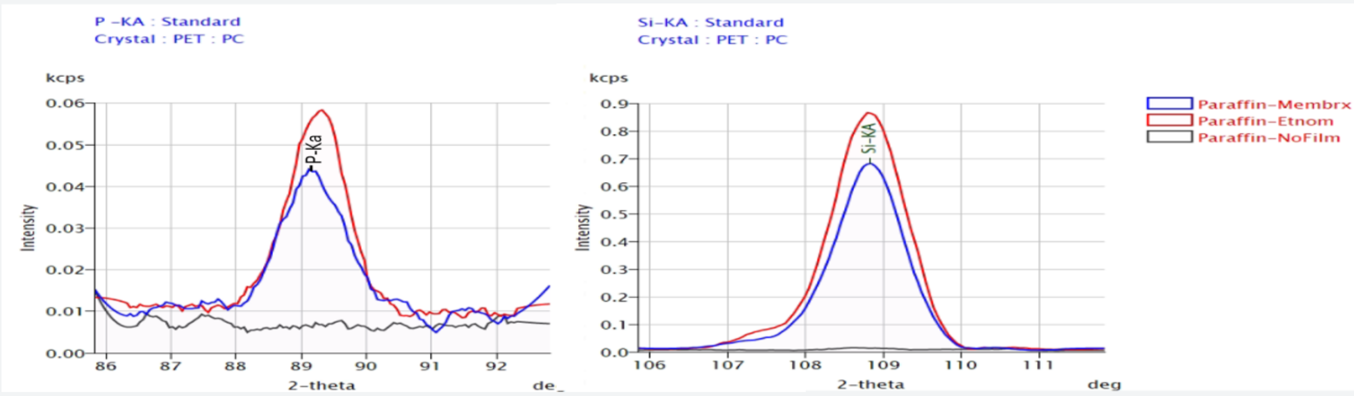

Figure 2. *A high purity paraffin wax puck was used as the control sample for the impurity analysis (black line). The spectra obtained for the Membrix RF® film (blue line) and Etnom® film (red line) exhibited detectable Si-Kα and P-Kα signals, with no significant additional elemental contaminants identified under the test conditions. Trace impurities of elements such as Ca, Zn, and Sb may also be present but are practically negligible for the purposes of XRF liquid analyses.*

4. Chemical Resistance Testing

Both films (prepared with liquid XRF analysis cups) were exposed to a comprehensive panel of solvents/fuels representative of petroleum product matrices. Film integrity was assessed by visual inspection for degree of film sagging/swelling and visible leaks following controlled exposure periods (15 min, 30 min, 1 hour, 2 hours). Results are summarized in Table 3.

Test Substance	Membrix RF® Film	Etnom® Film
Diesel Fuel	Excellent resistance	Excellent resistance
Gasoline	Excellent resistance	Excellent resistance
Mixture of Toluene/Acetone/Methanol	Good resistance	Good resistance
Mixture of Paraffins/Naphthenes/Aromatic Hydrocarbons	Excellent resistance	Excellent resistance
Mineral Oil	Excellent resistance	Excellent resistance

Table 3*. Chemical resistance results for Membrix RF® film and Etnom® film against five petroleum and organic test substances. Chemical resistance classification based on visual inspection for film deformation, swelling, sagging, and leakage during the stated exposure period.*

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Membrix RF® film demonstrated comparable chemical resistance to Etnom® film across all five test substances, including aromatic solvents (toluene) and oxygenated compounds (acetone, methanol). A comparator film, polypropylene, (shown in Figure 3) shows significant film sagging within minutes of exposure. Both Membrix RF® and Etnom® films performed comparably for aliphatic matrices — isoparaffins, naphthenes, and mineral oil. Both films exhibited good integrity upon exposure to diesel fuel, gasoline, and a solvent mixture of toluene, acetone, and methanol.

Figure 3 —Chemical Resistance of Diesel Fuel using

4.0 µm Polypropylene Film

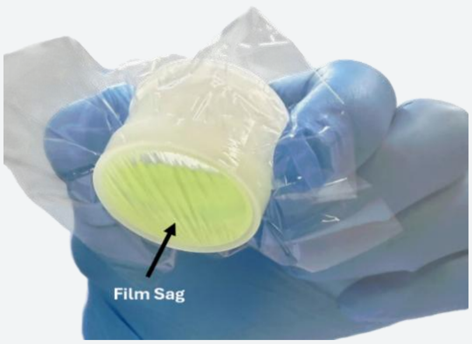

Figure 3. *Representative picture of a 4.0 µm polypropylene film with diesel fuel. Significant sagging was observed approximately 15 minutes after exposure.*

5. Film-to-Film Variability and Measurement Repeatability

An evaluation was conducted to assess film-to-film consistency within the same manufacturing lot as well as measurement repeatability of a single film analyzed multiple times. The S-Kα net intensity from a taurine pressed pellet (containing low S at <20 ppm to effectively evaluate signal variance) was used as the benchmark signal due to its stability and relevance for low-level sulfur analysis. Six individual films from the same production batch were tested for both Membrix RF® and Etnom® using identical sample preparation and instrument conditions. In this six film evaluation, Membrix RF® exhibited lower film-to-film variation than Etnom®.

A second repeatability test was performed by analyzing the same film six consecutive times for both Membrix RF® and Etnom®. This isolates instrument and film stability from manufacturing variation. Both films demonstrated comparable repeatability when the same film was measured repeatedly. Results are summarized in Table 4.

Test Substance (Different Films)	Membrix RF® (S Scan net int. kcps)	Etnom® (S Scan net int. kcps)
Film 1	0.0363	0.0417
Film 2	0.0350	0.0347
Film 3	0.0329	0.0346
Film 4	0.0359	0.0388
Film 5	0.0361	0.0414
Film 6	0.0330	0.0348
Average	0.0349	0.0377
Std Dev	0.0015	0.0034
%RSD	**4.39**	**9.03**

Test Substance (Same Film)	Membrix RF® (S Scan net int. kcps)	Etnom® (S Scan net int. kcps)
Film 1_REP1	0.03979	0.03482
Film 1_REP2	0.03387	0.04011
Film 1_REP3	0.03727	0.03778
Film 1_REP4	0.03588	0.03523
Film 1_REP5	0.03708	0.03773
Film 1_REP6	0.03562	0.03775
Average	0.0366	0.0372
Std Dev	0.0020	0.0019
%RSD	**5.44**	**5.22**

***Table 4**. Repeatability study on the film-to-film consistency within the same manufacturing lot/batch as well as the repeatability of a single film analyzed multiple times. Measurement times at S-Ka peak and background were kept to 10 seconds. Increased measurement times will improve the observed standard deviation and % RSD.*

6. Conclusion

Chemplex's Etnom® film has long been a widely used choice for XRF liquid fuel analyses, particularly within ASTM -based methods. In practice, laboratories often seek equivalent alternative films to ensure continuity during periods of limited availability or supply constraints. Under the conditions evaluated, Membrix RF® demonstrated comparable X-ray transmission, elemental background, chemical resistance, and measurement repeatability to Etnom®. These results indicate that Membrix RF® may be a suitable alternative for many industrial XRF sample preparation applications where a comparable thin film support is required.

Note – this evaluation is not intended to establish ASTM method compliance or formal equivalency of Membrix RF ® to Etnom ® under any ASTM standard.

Scope and Limitations

This evaluation compares 3.0 µm Membrix RF® and 3.0 µm Etnom® films under the experimental conditions described in this application note. Testing was performed using a Rigaku Supermini200 WD-XRF system and selected sulfur-containing reference materials, petroleum products, and organic solvents. Results represent the materials and film lots evaluated and may vary with instrument configuration, film thickness, film lot, sample matrix, exposure conditions, and measurement parameters. This study does not constitute formal ASTM method validation, certification, or approval of Membrix RF® for any ASTM test method.

Laboratories should independently evaluate Membrix RF® under their specific instrument configuration, sample matrices, analytical procedures, and quality requirements before implementing any change to established sample preparation materials or analytical procedures.