# "Laundry Detective": Identification of a Stain

The AccuTOF-DART[TM] was recently applied to an unusual analytical problem: finding the cause of oily stains on freshly laundered shirts (Figure 1). No cutting or extraction was required. Stained and unstained regions of the shirt were placed in the DART gas stream and the mass spectra were acquired.

The DART parameters were: helium gas, flow 3-4 LPM, gas heater set to 175 degrees C, positive-ion mode, PEG 600 exact mass reference standard. These conditions did not damage the shirt.

The mass spectrum of the stained region (Figure 2, top) showed a distinctive pattern of saturated fatty acids and their proton-bound dimers, monoglycerides, and triethanolamine. The same components were found in the dryer sheet (Figure 2, bottom). Elemental composition assignments were confirmed by exact mass measurements and computer-aided isotope pattern matching. The assignment of the fatty acids was confirmed by the presence of [M-H]⁻ peaks in the negative-ion DART spectrum (not shown). Fatty acid esters will not produce [M-H]⁻ peaks in negative-ion mode. After considering several possible sources of contamination, a matching pattern was found for the bargain-price fabric softener sheet that was placed in the clothes dryer with the shirts. The components causing the stains were released when the dryer sheet was exposed to high temperatures.

**Conclusion**

AccuTOF-DART was able to determine the nature and cause of oily stains on a shirt without causing any damage to the fabric. Solutions to the problem include lowering the dryer temperature, changing to a different brand of fabric softener, and re-washing the shirts.
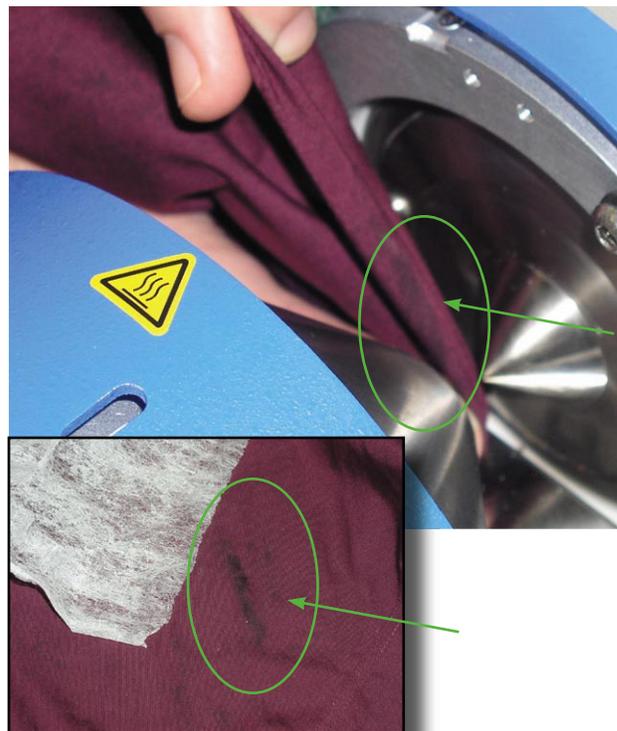


*Figure 1. Oily stain on a freshly laundered shirt placed in between DART ion source and AccuTOF mass spectrometer inlet. Inset: stain on shirt circled next to used dryer sheet.*
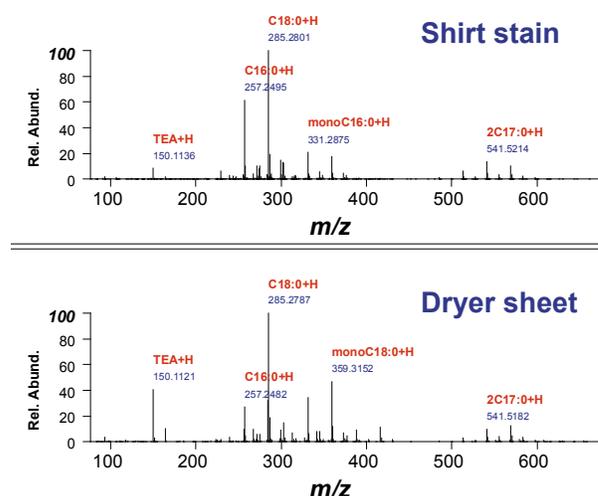


*Figure 2. (Top) AccuTOF-DART mass spectrum of stain on shirt. (Bottom) AccuTOF-DART mass spectrum of fabric softener sheet placed in the dryer with the shirts.*

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