

**Table 1: comparison between the 3 most relevant measurement techniques for portable scanners**

Feature/criteria	NIR (Near InfraRed Spectroscopy)	FTIR (Fourier Transform InfraRed spectroscopy)	XRF (X-ray Fluorescence)
Measurement principle	Analyzes absorption of NIR light by organic compounds	Measures absorption, emission, and reflection of infrared light by molecular vibrations	Measures characteristic X-rays emitted by a material when exposed to X-rays
Wavelength range	780 to 2500 nm	900 to 25000 nm	0,01 tot 10 nm
Sample preparation	None or minimal	Usually minimal; can be more complex for some samples, for example surface cleaning	None
Identification capacity	Organic compounds, especially those containing hydrogen, such as C-H, O-H, N-H functional groups	Detailed organic compounds, including C=O, C-O, N-H, O-H	Elemental composition (more sensitive to heavy elements)
Spatial Resolution	Limited, typically in the range of a few mm	Better, suitable for microscopic analysis. Resolutions of $\leq 100 \mu\text{m}$ are possible.	Limited, typically in the range of 3 to 10 mm
Sensitivity	Moderate	High	Very high for elements, not for molecular information
Quantitative Analysis	Limited, more qualitative	Quantitative analysis is possible to a certain extent	Quantitative analysis
Speed	Very fast (seconds)	Fast (seconds to minutes)	Very fast (seconds)
Non destructive	yes	yes	yes
Portability	Portable devices available	Portable devices available	Portable devices available
Costs	Moderate	Moderate to high	High
General Applications	Rapid identification of polymers, plastics	Detailed analysis of polymers, identification of additives, contaminants	Determination of elemental composition, heavy metals analysis
Advantages	<ul style="list-style-type: none"> <li>- Quick and easy to use</li> <li>- No sample preparation required</li> </ul>	<ul style="list-style-type: none"> <li>- High sensitivity and specificity</li> <li>- Quantitative and qualitative</li> <li>- Can identify complex mixtures</li> </ul>	<ul style="list-style-type: none"> <li>- No sample preparation required</li> <li>- Very accurate for elemental analysis</li> <li>- Can analyze coatings and multilayer structures</li> </ul>
Limitations	<ul style="list-style-type: none"> <li>- Mainly sensitive to functional groups containing H (e.g., hydrocarbons, hydroxyl, amines, amides)</li> <li>- Lower sensitivity for black or very dark samples (less reflective)</li> <li>- Lower sensitivity compared to FTIR</li> <li>- Less effective for complex mixtures</li> </ul>	<ul style="list-style-type: none"> <li>- Sample preparation can affect results</li> <li>- Lower sensitivity for black or very dark samples (less reflective)</li> <li>- Requires reference libraries</li> <li>- More expensive equipment</li> </ul>	<ul style="list-style-type: none"> <li>- Limited information on molecular structures</li> <li>- Less effective for organic compounds</li> <li>- Equipment costs and complexity</li> <li>- The portable X-ray source requires additional safety measures (e.g., for transport)</li> </ul>