

Comparison Matrix

	Technique	Description	Advantages	Disadvantages
Destructive	Focal Depth Indexing	<ul style="list-style-type: none"> Coating partially removed down to substrate Microscope imaging Focal plane subtraction (Coating Edge - Substrate Surface) 	<ul style="list-style-type: none"> Low cost Simple operation 	<ul style="list-style-type: none"> Destructive test Operator dependent Sample preparation and coating alteration Limited accuracy/resolution Only works for single layer coating Provides no information about coating properties.
	Indentation	<ul style="list-style-type: none"> Indentation with controlled force normal to substrate/coating surface Hardness variation on air/coating and coating/substrate interface Thickness of coating layer from recorded force/displacement graph 	<ul style="list-style-type: none"> Provides some additional information about coating hardness and adhesion. 	<ul style="list-style-type: none"> Expensive hardware to measure soft coatings Only single layer coating Destructive test Sample preparation and coating alteration
	Stylus Profilometer	<ul style="list-style-type: none"> Coating partially removed down to substrate Recording of tip deflection during surface scanning 	<ul style="list-style-type: none"> Simple operation 	<ul style="list-style-type: none"> Only works for single layer coating Sample preparation and coating alteration Destructive test Slow scan speed Provides no information about coating properties.
Non-Destructive	Confocal Raman Microscopy	<ul style="list-style-type: none"> Distinct Raman spectra depending on coating composition in focal plane Shifting focal plane in the z-axis Depth profiling by measuring specific compound as function of depth Quantity actually measured is 'thickness divided by refractive index' 	<ul style="list-style-type: none"> No sample preparation Non - destructive Can measure multiple coating layers 	<ul style="list-style-type: none"> Depth resolution ($\geq \pm 0.5 \mu\text{m}$) Relatively expensive instrumentation Requires skilled operator Requires refractive index of coating layers; this must be assumed, or measured using a separate test piece on a separate instrument e.g. prism coupler Very slow (no potential to be used in production)
	Optical Profilometry/ Interferometry	<ul style="list-style-type: none"> White light interferometer Good contrast fringes only where surface is in focus 3D surface map Quantity actually measured is 'thickness divided by refractive index' 	<ul style="list-style-type: none"> No sample preparation Non-destructive Nanometre accuracy (strictly speaking, nanometre <i>reproducibility</i> - results may be highly inaccurate if wrong refractive index used) Simple operation 	<ul style="list-style-type: none"> Only translucent coatings Relatively expensive instrumentation Requires refractive index of coating layers; this must be assumed, or measured using a separate test piece on a separate instrument e.g. prism coupler Thickness obtained is a function of refractive index selected; this is a large source of thickness uncertainty Provides no information about coating properties. Little sensitivity to films $< 2 \mu\text{m}$ thick Very slow (no potential to be used in production)
	Spectral Reflectometry	<ul style="list-style-type: none"> White light source focused on coating surface Destructive/constructive interference modulation as function of wavelength Analysis of spectral composition of reflected signal Quantity actually measured is 'thickness multiplied by refractive index' 	<ul style="list-style-type: none"> Relatively low cost instrumentation No sample preparation Simple operation Non-destructive Multiple layers simultaneously Nanometre accuracy (strictly speaking, nanometre <i>reproducibility</i> - results may be highly inaccurate if wrong refractive index used) Provides limited film-composition information (via changes in film absorption at different wavelengths). 	<ul style="list-style-type: none"> Only translucent coatings Requires refractive index of coating layers; this must be assumed, or measured using a separate test piece on a separate instrument e.g. prism coupler Thickness obtained is a function of refractive index selected; this is a large source of thickness uncertainty
	Beam Profile Reflectometry (BPR)	<ul style="list-style-type: none"> Low-power laser beam focused on coating surface Destructive/constructive interference modulation as function of laser incident angle, which is equivalent to spatial position within beam Analysis of spatial composition of reflected signal Thickness and refractive index are obtained independently and simultaneously. 	<ul style="list-style-type: none"> Relatively low cost instrumentation No sample preparation Simple operation Non-destructive Multiple layers simultaneously High throughput (potential production-line technique) Provides refractive index directly - no need to assume or measure separately Largest source of thickness uncertainty removed, hence true Ångstrom-to-Nanometre accuracy. Provides measurement of film birefringence (related to film stress) Trivial to combine on same platform with spectral reflectometry When combined with spectral reflectometry, provides greatly improved film-composition information (because thickness uncertainty is removed). 	<ul style="list-style-type: none"> Only translucent coatings



This table is based on A. Forster, T. Neudeck and S. Blatcher (PA Consulting Group), "Approaches to the Physico-Chemical and Mechanical Characterisation of Functional Coatings, Part II", Medical Device Technology, November/December 2008 pp. 42-47. Modified with permission.