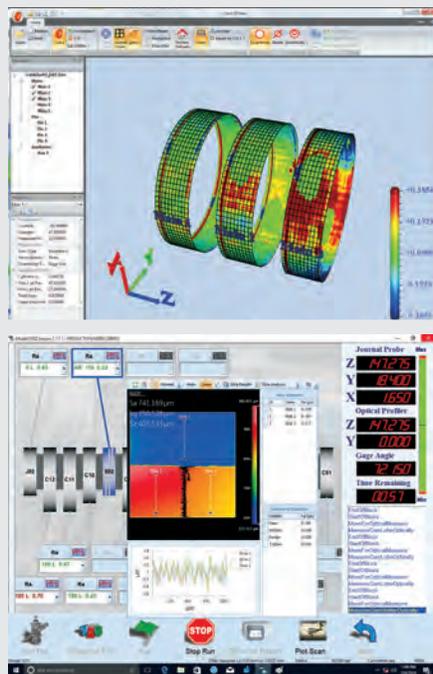


# ADCOLE

TRUSTED ACCURACY

Automated Gage, Accessory & Software Solutions for Electric and Hybrid Vehicles

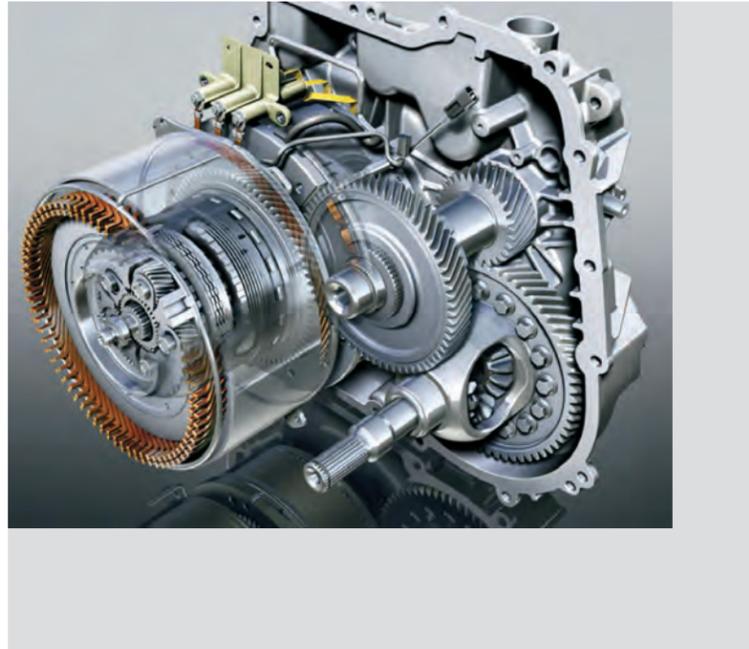


# AUTOMATED GAGE AND ACCESSORY SOLUTIONS FOR NEW ENERGY VEHICLE (NEV) MANUFACTURING.

Whether you are manufacturing parts for pure battery electric, mild hybrid or plug-in hybrid vehicles, Adcole has automated gaging solutions for your high-performance manufacturing needs. Engineered to provide accurate and repeatable data, Adcole metrology solutions provide electric motor, gearbox/transmission, output, balance, eccentric and other shaft manufacturers certainty that key production specifications can be held. Manufacturing tolerances as low as single-micron ( $\mu\text{m}$ ) levels can be supported with accuracy capabilities reaching sub-micron performance. With electric motor rotation speeds escalating toward 20,000 RPM and beyond, Adcole gages are uniquely capable of providing the quality control data necessary to build tomorrow's sophisticated NEVs.

## Some key parameters that Adcole gages and accessories can evaluate for NEV manufacturers include:

- Bearing diameter
- Roundness
- Straightness
- Chatter
- Surface roughness



## In addition, linear features are also offered, such as:

- Axial locations
- Axial scans of bearing surfaces to detect bearing crowning or barreling
- Parallelism
- Perpendicularity

The ability to accurately measure non-round, eccentric features, and hard-to-detect grinder issues such as chatter is a key part of the Adcole solution for NEV requirements and sets Adcole apart from other metrology solution providers. Evaluating each of these parameters is essential for fabricating quiet, efficient, and durable NEVs.

# AUTOMATED SIZE, FORM & PROFILE GAGES

## Model 911 Automated Metrology Systems

The Adcole Model 911 helps organizations improve part quality, reduce scrap, and increase manufacturing efficiency. The 911 gage is available in 610mm (24"), 920mm (36"), 1530mm (60"), 2290mm (90"), 2670mm (105") part capacities, offering an automated metrology solution for every manufacturing need. The versatile 911 gage is durable and ready for use on the shop floor as well as the quality control lab.

### Benefits of the 911 gage include:

- Reduces labor and material costs with superior gage accuracy and reliability
- Eliminates operator error with one button testing, concise pass/fail inspection reports, and more
- Measures multiple part types and complex geometries
- Provides numerical and graphical representation of complex metrology data
- Enables manufacturers to measure multiple part types using a flexible gage platform
- Available with optional LightSCOPE™ and DiaMetric™ Follower System (see following details)



The Model 911 is available in different length capacities

## 1302, 1304 & 1306 High-Speed, multi-head Horizontal Gages

Model 1302/04/06 gages are horizontal, multi-head Cylindrical Coordinate Measuring Machines (CCMM) that provide extremely accurate manufacturing measurement data for rotating components at a higher throughput than single-head models.

Manufacturers choose these gages for fast inspection speeds in a flexible platform for performing audit gage or high-speed in-line production gage tasks. Changing between part types is simple with programmable follower positions and an optional power tailstock. 1302/04/06 gages can be outfitted for automatic loading/unloading via a gantry or robot.

### Benefits of the 1302/04/06 gage include:

- Supports 2–4 independent measuring heads that can move to positions for easy part load/unload
- Measures up to 60 parts per hour
- High sample rate of 3600 data points per revolution (every 1/10 of a degree)
- Simple and user-friendly programming
- Can be outfitted for audit tasks or inline production operations



1302 dual-head gage

## Both horizontal and vertical gages can measure parameters such as, but not limited to;

- Bearing diameter
- Chatter
- Roundness
- Straightness
- Axial locations
- Parallelism
- Perpendicularity

# AUTOMATED SURFACE ROUGHNESS GAGES

## Model 1000 and 1000-Z Automated Surface Finish Systems

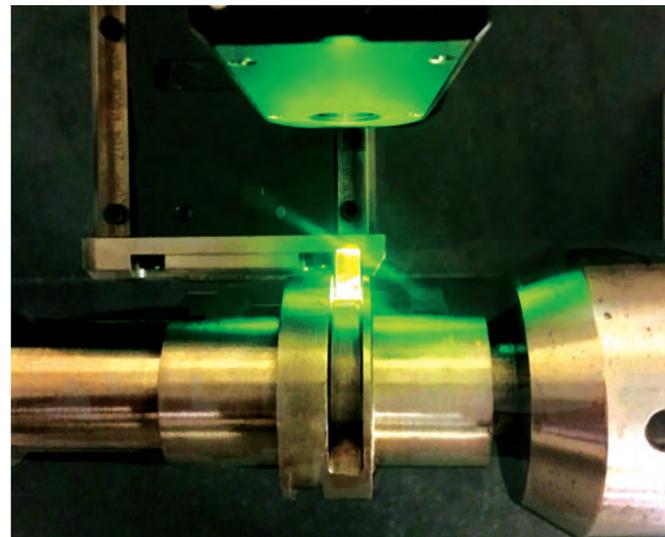
The Adcole Model 1000 and 1000-Z gages are our most advanced automated systems for measuring surface roughness and finish on shafts and other cylindrical components. These models are pre-programmed for simple operation to aid in repeatable and optimized workflows. In addition to its unprecedented accuracy, this product is also the fastest system for taking critical surface finish measurements.

The Model 1000 Gage includes horizontally and vertically configured Taylor Hobson non-skidded probes for tactile surface finish measurements on multiple surface locations. In addition to the tactile capabilities of the standard Model 1000, the Model 1000-Z adds a Zygo non-contact optical interferometer probe for 3-dimensional surface finish measurement capabilities, allowing for more complex surface finish analysis and access to features not accessible by standard tactile probes.

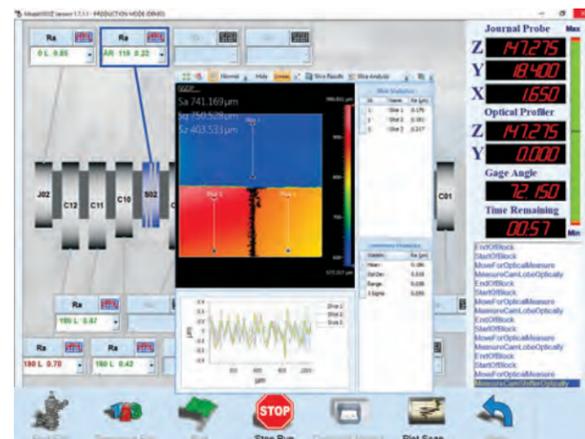


*The 1000 Gage offers precise surface roughness measurement for cylindrical components*

*The Model 1000-Z features both optical and tactile measuring heads for high precision surface measurement of turned parts*



*The 1000-Z non-contact interferometric probe greatly expands on the measurement capabilities from the diamond tipped contact probe of the standard Adcole 1000 gage*



*Intuitive user interface for easy programming and results reporting*

### Benefits of the 1000 gage include:

- Easy-to-use operator interface and software
- Windows-based interface for flexibility and compatibility
- High data density: 2000 data points per mm
- Self-contained, sealed and air-conditioned operator console for both shop floor and lab environments
- Simple menu-driven utility programs for making changes or setting up a new part
- Statistical data can be maintained for process control or forwarded to centralized SPC data collection point
- Stylus tips are calibrated and verified using a multi-patch master
- Gage sits on isolator mounts to eliminate objectionable vibration
- Fast cycle times permits more parts to be inspected per shift

### Model 1000-Z additional enhancements:

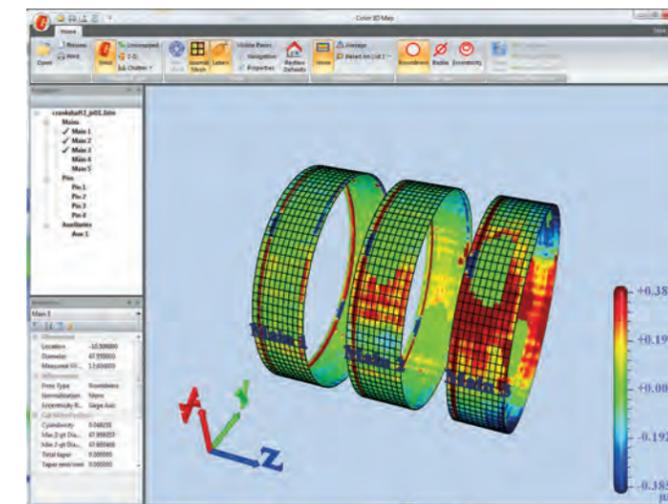
- Both tactile and optical, non-contact surface finish inspection within the same machine package
- Precise laser Interferometer provides 0.005 μm radial resolution for very accurate optical surface finish measurements
- Offers quantifiable means to measure parameters such as waviness that standard roughness measurement systems cannot measure

# ADCOLE METROLOGY SOFTWARE

## 3D Color Map Software—Part Inspection Solution

Through decades of software development combined with Adcole's unique and comprehensive applications expertise, Adcole's suite of software offerings enable manufacturers to drill-into measurements for benefits that transcend typical gage results. Capabilities range from visible cues of manufacturing results, to grinder performance improvement through process loop feedback, and even unique filtering capabilities to reduce the effect of dirt in the environment, Adcole offers a wide-range of software designed to improve quality, productivity and profitability unique to your operations.

The Adcole 3D Color Map software helps organizations improve their manufacturing process by quickly revealing non-conformity issues that are often overlooked in standard audit measurements. 3D Color Map Software is engineered to enable users to fully error-map camshaft, crankshaft, camshaft tubes, pump rings, and spline components. The 3D inspection software tool reports roundness, profile, and size error run parameters, plus many other parameters.

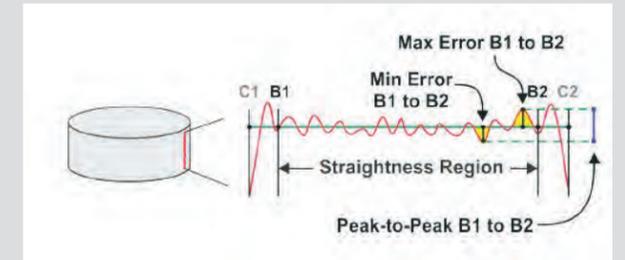


*3D Color Map software enables users to troubleshoot production issues with graphical rendering of the part*

## Material Build-Up & Advanced Straightness Software

Adcole Material Build-Up & Advanced Straightness software is an advanced linear scan data analysis package. The software is used to detect any "material build-up" on the leading or trailing edge of the scan. Material build-up is usually found in a zone outside of the straightness calculation range.

This proprietary software solution provides the means to specify the linear scan reduction method for determining the area for straightness, concavity and convexity, including two edge sections for material build-up.



*Material Build-Up and Advanced Straightness software is used to detect "material build-up" on the leading or trailing edge of a linear scan*

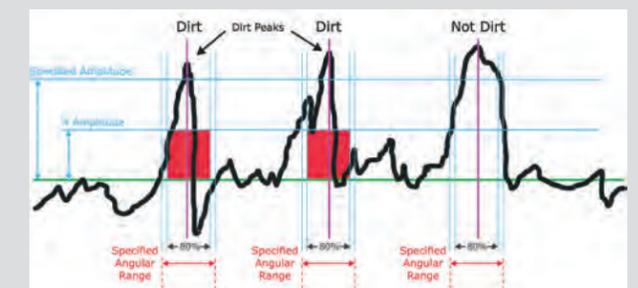
### Material build-up and advanced straightness software measures the following parameters:

Barreling	Maximum Error per Region	
Concavity	Minimum Error per Region	Straightness
Convexity	Profile Error	

## Asperity Removal Software

An asperity is a small projection from the surface such as dirt which produces a measurement result that is not intended to be a part of the component that is being measured. Adcole Corporation's Asperity Removal Software can filter dirt measurements from radial and linear data, based on the definitions set up by the operator.

Asperity removal eliminates defined dirt spikes by averaging data points on either side of the dirt spike, and connecting the points. With the dirt removed, the refined error data can focus on the real variance from the nominal values.



*Asperity removal eliminates dirt spikes by averaging data points on either side of the dirt spike, and connecting the points*

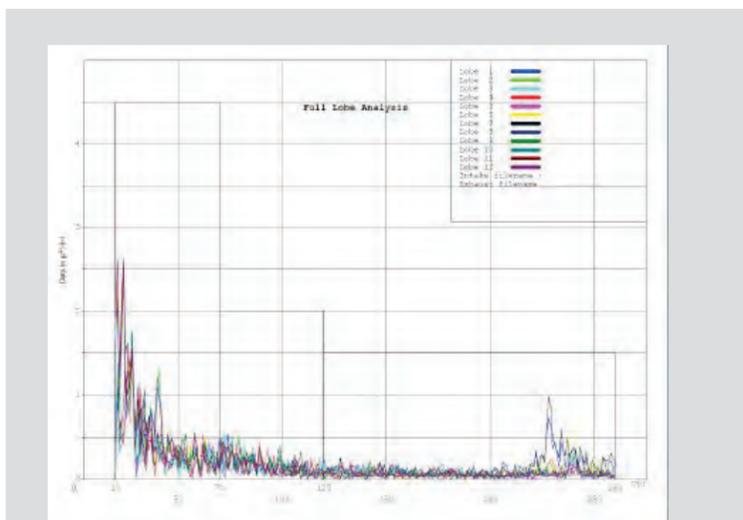
## REAL TIME FFT Chatter Analysis

Chatter is the undulating pattern of marks on a machined surface, usually caused from unwanted vibration during the grinding process. Adcole Chatter Analysis software detects high frequency undulations, and determines the measured amplitude at each specific frequency or undulations per revolution (UPR). The report from this analysis is useful in troubleshooting and correcting manufacturing issues prior to parts being out of specification and helps to prevent out of specification components from entering the supply chain.

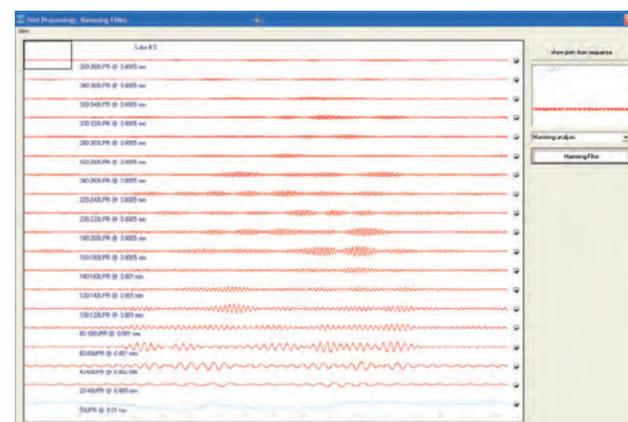
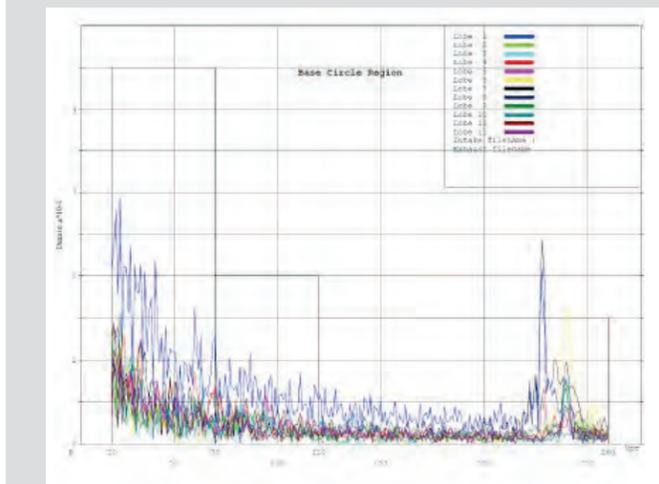
Adcole FFT Chatter Analysis Software is a tool that allows organizations to pinpoint grinder performance issues that occur while producing precision-ground rotary shafts. The software package includes features such as frequency analysis of error data over a specified UPR range using standard single or multi-region square tolerances, or a tolerance curve based on a formula or file. Chatter Analysis Software allows users to look at full 360° data set, or at a specific angular region within the error file.

### Chatter Analysis Software benefits:

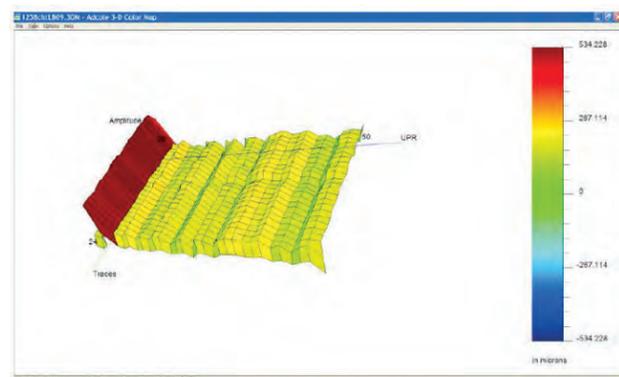
- Allows manufacturers to detect chatter to obtain insights on the manufacturing processes for troubleshooting of production or part quality issues
- Provides actionable data to improve the manufacturing process, find manufacturing efficiencies and boost productivity
- Offers multiple chatter analysis methods and tolerance types, providing a comprehensive analysis tool
- Provides clear outputs in both tabular data and graphical format
- Can be integrated with existing inspection sequences or as a stand-alone post process inspection



*The FFT Chatter Analysis software provides actionable data that helps your organization improve your quality assurance process*



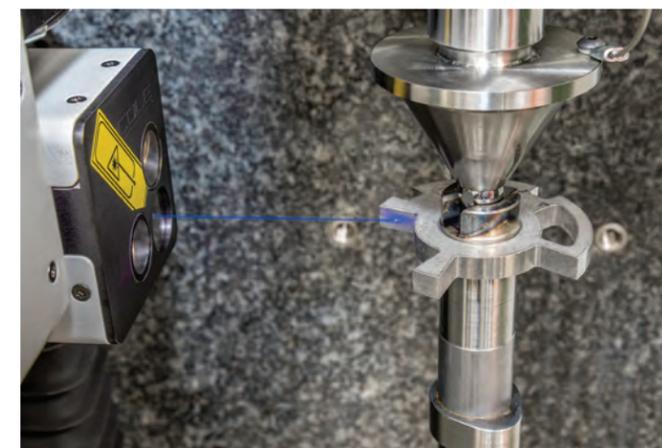
*Post processing of results such as Hamming Analysis provide deeper insights on data*



*3D-Modeling of chatter analysis results*

## LightSCOPE™ Automated Optical Measurement System

Designed to offer optical measurement capabilities to the versatile 911 gage, the LightSCOPE benefits NEV manufacturers with fast, efficient, and highly accurate measurement data. The LightSCOPE system is ideal for measuring challenging features on rotor shafts, eccentric shafts, compressor shafts, base shafts, and other precise cylindrical parts.



*The LightSCOPE laser triangulation measurement system*

### The LightSCOPE system benefits:

- Non-contact optical measurement system
- Measures axial features such as lobe position, width, and spacing
- Engineered for measuring complex components like sensor wheel angles, timing notches, and dimples on assembled camshafts
- Affordable upgrade expands Model 911 gage versatility
- Fast linear scanning capability provides significant time savings over tactile solutions
- Provides cutting-edge contact and non-contact measurement technologies in one system
- Additional feature measurement capability expands the parameters of tactile measurement

## DiaMetric™ Follower Solution

The DiaMetric follower system enables NEV manufacturers to obtain 5 times greater accuracy, achieving sub-micron performance levels of  $\pm .2 \mu\text{m}$  when measuring diameters on their existing Adcole 911 gage.

Using the DiaMetric follower system, organizations can confidently measure concentric diameters on eccentric shafts, robotic shafts and electric motor rotors with tolerances of  $<10 \mu\text{m}$ . In addition, manufacturers can maintain absolute diameter accuracies with fewer gage calibrations.

### The DiaMetric follower system benefits:

- Extends submicron diameter accuracy ( $\pm .2 \mu\text{m}$ ) and repeatability for tighter diameter measurement tolerances
- Offers an affordable means to significantly improve diameter data using your existing 911 gage
- Allows manufacturers to consistently measure parts with a significant reduction in gage calibration, by eliminating 2 major variables that can contribute to measurement errors
- Provides extremely accurate concentric diameter measurements of parts with tolerances of  $<10 \mu\text{m}$
- Includes rapid installation with minimal gage downtime
- Enables manufacturers to easily upgrade your existing 911 gages for improved diameter measurement accuracy



*The DiaMetric follower system enables NEV manufacturers to confidently measure concentric diameters on electric motor rotors to within  $<10 \mu\text{m}$*

# ADCOLE MACHINE SUPPORT

Adcole machine support is provided by an expert field service team that is backed by 50 years of industry experience and ISO 9000 annual certification. Machine and application support, machine retrofit and upgrade services, plus inspection services are offered to our global customer base. Regular and after-hours email and phone support is available.

The electric vehicles of tomorrow will require precise, high RPM components. Manufacturers who can deliver high quality parts will be positioned to capitalize on the opportunity. Ask your sales representative about Adcole gages and accessories for electric vehicle applications.

## GLOBAL OFFICES



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