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RESIDUAL STRESS MEASUREMENT FOR QUALITY CONTROL OF SHOT PEENING

The magnitude and depth of the layer of compressive residual stress produced by shot peening is critical to achieving increased component fatigue strength. Although the Almen strip provides a practical means of monitoring the intensity of shot peening, the Almen strip arc height depends upon the area under the stress-depth plot, and is not sufficient to guarantee both the magnitude and depth of the residual stress distribution produced. The subsurface stress distribution must be measured for reliable quality control of shot peening.

The best developed and most accurate means of measuring shot peening residual stress distributions with depth is by x-ray diffraction (XRD).[1] XRD procedures have been established by the SAE,[2] and have been widely used since the 1970's for the determination of subsurface stress distributions in automotive and aerospace applications.

Non-destructive surface residual stress measurements alone are not adequate to determine whether a part has been shot peened properly.[3] Surface residual stresses simply are not indicative of the processing history. Similar surface residual stresses do not insure similar processing, as demonstrated in Figure 1. To adequately determine both the magnitude and depth of the compressive layer produced by shot peening, measurements must be made as a function of depth.

Lambda Research has developed novel automation technology[4] which allows subsurface residual stress profiles to be obtained automatically, accurately, and cost effectively. It is now possible to determine full stress distributions for quality control and process development in routine applications of shot peening to a wide range of materials, including martensitic steels, austenitic stainless steels, nickel, and aluminum alloys.

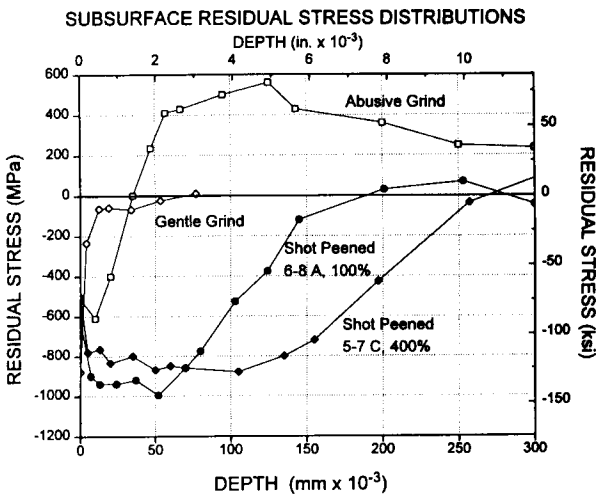

Fig. 1 - Comparable surface stresses produced by radically different processing showing the need for subsurface measurement.

• BENEFITS

The availability of residual stress measurement for quality control of shot peening offers numerous benefits:

Manufacturing Consistency
Uniform residual stress distributions produced by shot peening can be achieved, improving production efficiency, reducing rejection rates, and lowering overall manufacturing costs.

Improved Component Life
Quality control testing can virtually eliminate field failures, reduce warranty costs, and assure customer satisfaction.

Process Optimization
Residual stress testing allows informed engineering decisions for the optimization of the peening process. Peening parameters can be chosen to produce the depth and magnitude of compression giving the best fatigue life at minimum time and cost.

Objectivity
With the use of an accredited independent laboratory, results are accurate, timely, and accepted world-wide.

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• QUALITY ASSURANCE

Lambda Research is the leading independent laboratory providing x-ray diffraction testing services for over twenty years. Thousands of individual residual stress studies have been performed for virtually every major automotive, aerospace, and nuclear manufacturer. All of the apparatus, software and procedures employed, conform to SAE and ASTM standards, where applicable. All calibrations are performed to ASTM E1426 for the determination of x-ray elastic constants and instrument alignment is verified to ASTM E915. Residual stress measurement methods conform to SAE J784a.

Lambda Research is accredited by the American Association of Laboratory Accreditation, and is certified by the principal automotive, aerospace and nuclear manufacturers. Results are provided directly to the client, and all data are archived indefinitely. The Quality Assurance program at Lambda Research is registered to ISO 9002, insuring international recognition and acceptance.

• SAMPLE REQUIREMENTS

The samples submitted for residual stress analysis may be either shot peened coupons, or actual components. The coupon, or portion of the sample tested, must fit in an envelope of approximately 2 in. x 2 in. x 1.5 in. Residual stress measurements are made at a single position and direction on the face of the component as a function of depth. The direction and location of measurement must be specified when the samples are submitted. Contact the laboratory for detailed requirements.

Full components such as gears will be sectioned to reduce them to the required coupon dimensions dictated by the automation apparatus. Strain gage monitoring of, and correction for, sectioning stress relaxation is available. For non-automated measurements on any sample geometry, either in the lab or field, contact Lambda Research.

References:

(1) Paul S. Prevey, "X-Ray Diffraction Residual Techniques," Metals Handbook: 9th ed., Vol. 10, Metals Park, OH: ASM, 1986, pp. 380-392.
(2) Residual Stress Measurement by X-Ray Diffraction, SAE J784a, 2nd ed., SAE, Warrendale, PA, 1971.
(3) Paul S. Prevey, "Problems with Non-Destructive Surface X-Ray Diffraction Residual Stress Measurement," Practical Applications of Residual Stress Technology, Materials Park, OH: ASM, 1991, pp. 47-54.
(4) Patent Pending.

LAMBDA RESEARCH
5521 FAIR LANE
CINCINNATI, OH 45227-3465
U.S.A.

PHONE: (513) 561-0883
FAX: (513) 561-0886
E-MAIL: lamresch@iac.net