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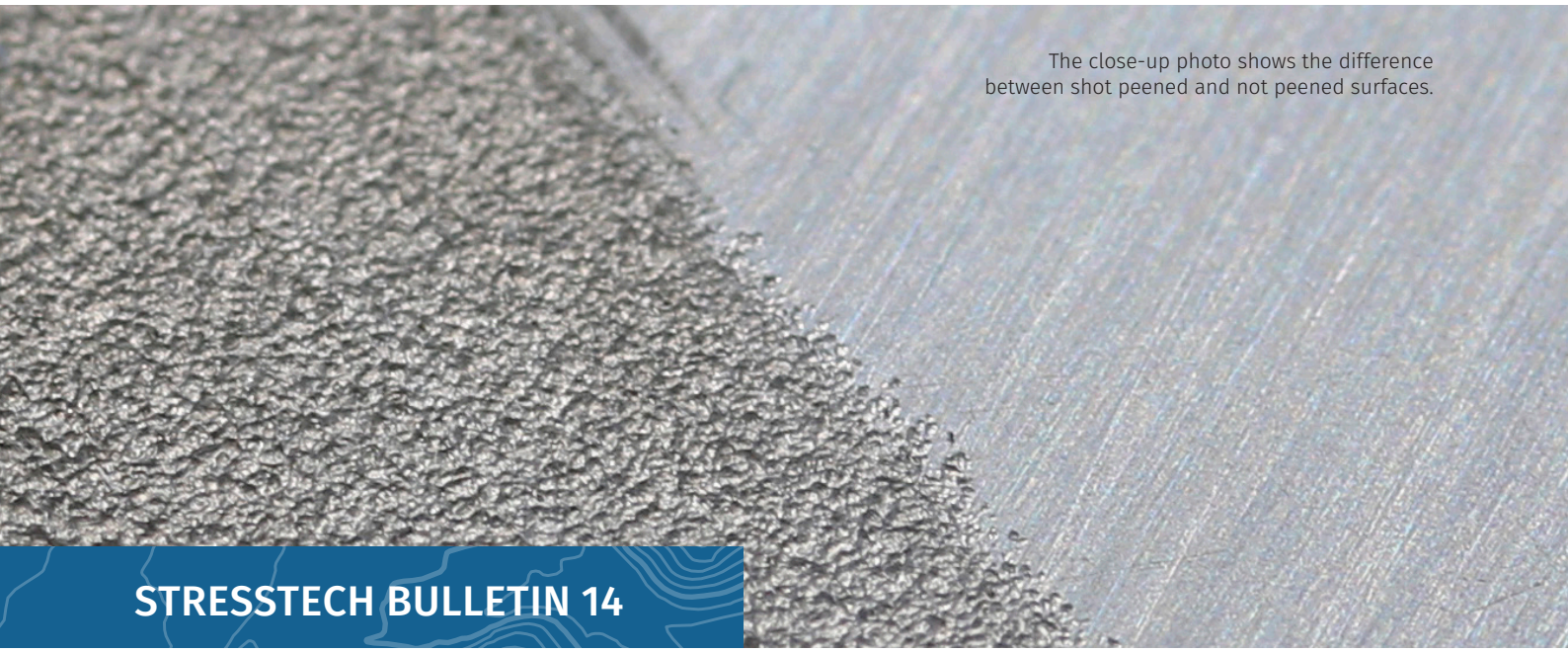


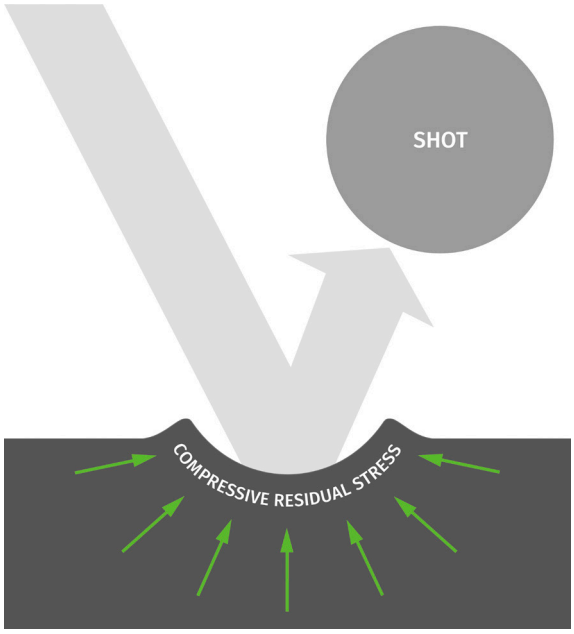
The close-up photo shows the difference between shot peened and not peened surfaces.

STRESSTECH BULLETIN 14

Shot Peening Residual Stresses

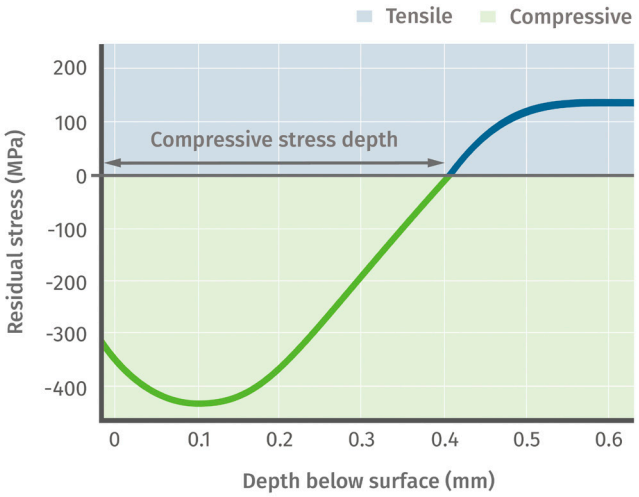
Cold working causes plastic deformation that creates residual stresses. The degree and sign of the residual stress depend on degree and type of the working process. Shot peening is a cold working process in which the surface of a component is peened with small spherical balls called shots. The process induces plastic deformation on the surface, relieves surface tensile stresses and introduces beneficial compressive residual stresses. Shot peening is a similar process with surface rolling, both deform the surface plastically to develop a compressive residual stress depth profile.

Text: Murat Deveci, Figures: Stresstech

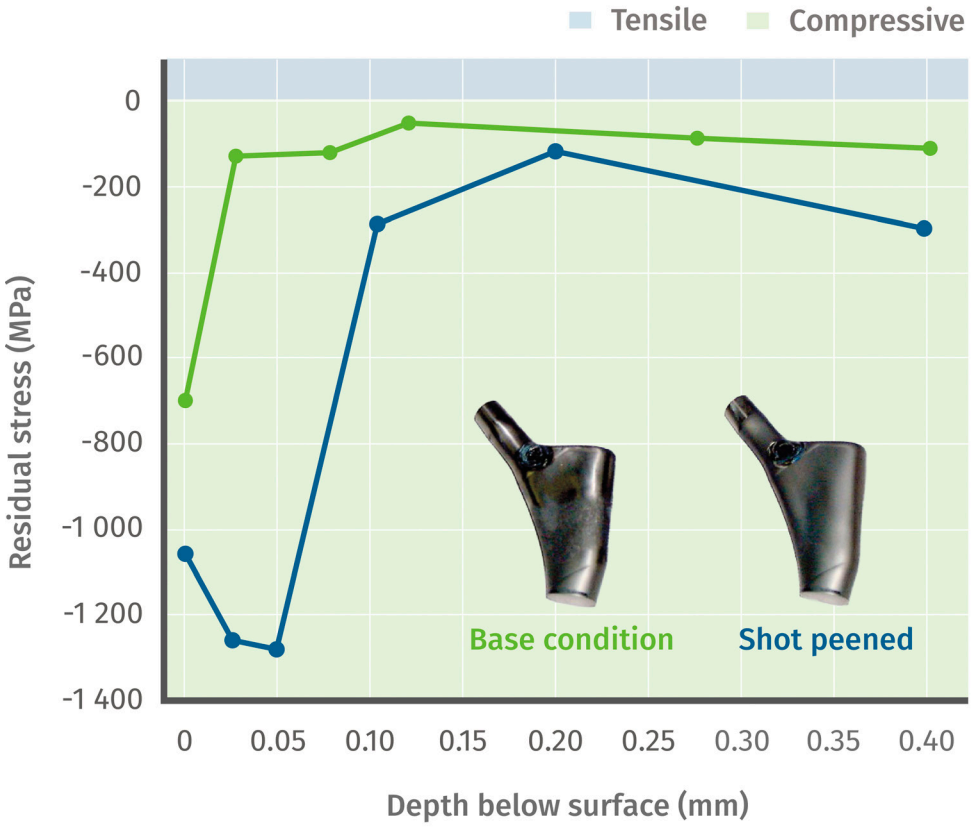


Stress formation during shot peening process.

Typical shot peened surface's stress depth profile. In this example, over 400 MPa of compressive residual stress is induced on the subsurface layers of the component. Through the depth, changes in the stress direction and values are confirmed by X-ray diffraction.



NOVA INSTRUMENTS



Shot peening has a place in many industries, including the health industry. The graph shows a Titanium hip joint's residual stress depth profile before the shot peening and after the shot peening. The process is applied to improve the hip joint's durability by creating higher compressive residual stresses on the surface and subsurface layers. The after-process graph shows that the aim is achieved.

Inducing compressive residual stresses on a component's surface, increases the resistance to fatigue failures and stress corrosion cracking (SCC) thus lengthening the lifetime of the component.

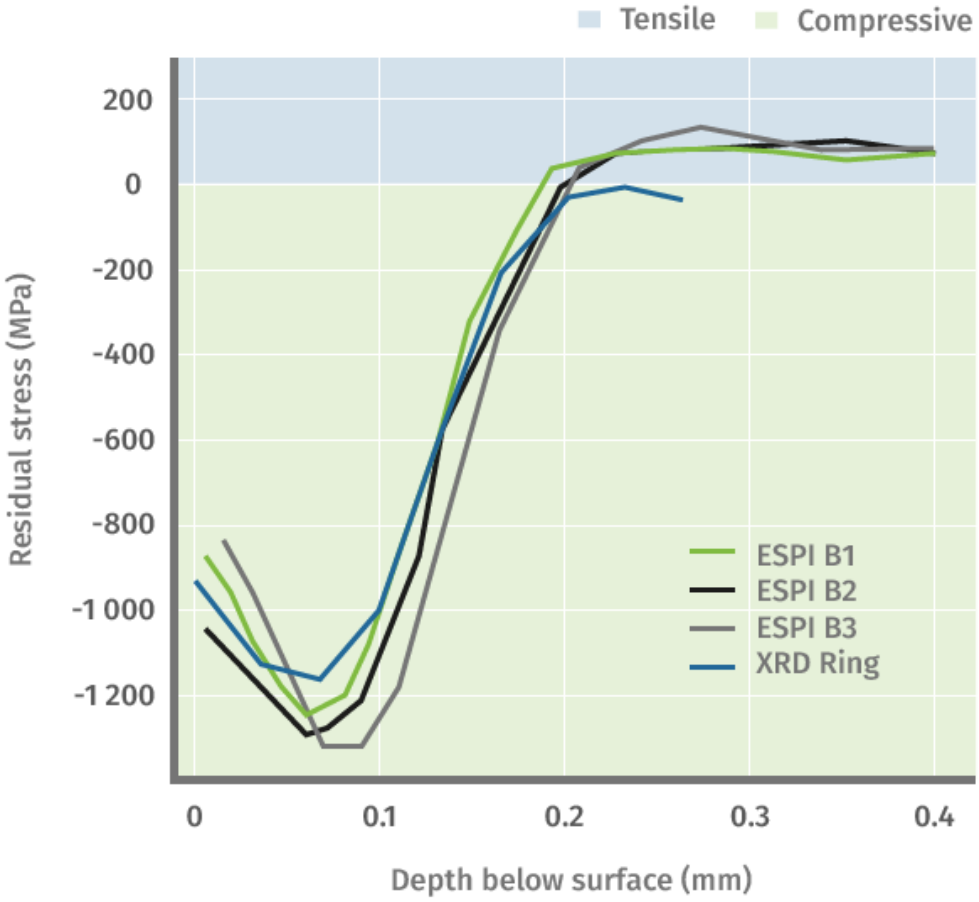
It is easy to apply shot peening on steel, aluminum, titanium, nickel base alloys and some ceramics. For the components which need high cyclic fatigue and strength, such as springs, gears, camshafts, crankshafts and turbine blades shot peening is a crucial step in the production.

Barkhausen noise analysis could be used to show the difference between a shot peened and not peened residual stress depth profile. Barkhausen noise method could be utilized as an automated inspection method to separate shot peened and not shot peened parts non-destructively. In relatively soft steels, the Barkhausen noise signal level consistently increases, in hard martensitic (carburized or surface hardened) materials, Barkhausen noise signal level decreases.

Barkhausen noise can quantify the subsurface stress without the need of removing the surface layer. However, Barkhausen noise analysis requires a calibration study to produce MPa values. When Barkhausen noise is used, evaluation of shot peened components is non-destructive and fast.

Shot peening affects various properties of the component such as residual stress distribution, surface roughness, structural integrity (distortion), hardness, crack initiation and propagation.

In his paper, **Prof.Schulze** has divided the parameters which influence the results of shot peening treatments into three categories as device related, shot related and



The graph shows four different stress depth profile of a shot-peened steel part. First, the part has been measured with X-ray diffraction (XRD Ring) and then consecutively three times with ESPI/Hole drilling technique (ESPI B1, B2, B3) to verify reliable and consistent results.

workpiece related. The paper describes the equipment related parameters as coverage, impact angle, peening time, shot velocity workpiece parameters as geometry, hardness, temperature and shot related parameters as shape, size, mass, and so forth. [1]

Another example of shot peening stresses is given above. In this example, the residual stress depth profiles are created by Prism equipment which works with a technology based on a combination of traditional hole drilling and ESPI methods.

In traditional hole drilling, by removing a volume of material, the stress equilibrium is changed. Moreover, the remaining material re-balances its stress fields, and this relaxation and surface distortions are measured as changes in electrical resistance.

ESPI – Electronic Speckle Pattern Interferometry is a non-contact technique capable of measuring and monitoring non-uniform strain fields at high resolution.

To sum up, it can be said that shot peening induced residual stresses are quite beneficial. However, there is a need to confirm their values and distribution through the depth. There are several methods to create stress depth profiles as X-ray diffraction, Hole drilling with ESPI or Barkhausen noise.

Stresstech is a research oriented company with more than 30 years' experience in residual stress engineering and shot peening stress evaluation. Feel free to contact us to learn more about residual stresses and shot peening stress determination.

www.stresstech.com

Sources

[1] Characteristics of Surface Layers Produced by Shot Peening, Volker Schulze, Institut für Werkstoffkunde I, Universität Karlsruhe (TH), Karlsruhe, Germany
[2] Non-destructive Evaluation of Residual Stress Depth-profiles by Barkhausen Noise Analysis and their Validation by XRD Method Combined with Electrochemical Surface Removal, P. Jacob, S. Marrone