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WRITING PORTFOLIO

1 **An Introduction to Laser Shock Peening**

Technical overview designed to quickly summarize a complex subject.

2 **Five Amazing Facts About Laser Peening**

Deeper dive into some of the nuances with more of a marketing tone.

3 **Book Excerpt: *The Ballad of Clay Moore***

Short, powerful chapter from my self-published adventure novel.

4 **Popular Chess Openings: An Infographic**

Simple infographic about some common chess openings and their strengths.

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Updated: February 2023

An Introduction to Laser Shock Peening

Laser shock peening (LSP) is a powerful surface enhancement method for improving metal fatigue resistance. The process employs high-energy laser pulses to impart deep compressive residual stress in metal components. This strategic application provides protection against fatigue cracking, extending service lifetimes and preventing the failure of critical parts.

What is Metal Fatigue?

Metal fatigue cracking is a common failure mode in high-stress or high-cycle components. Microscopic cracks form near the material surface and propagate undetected until the part suddenly and catastrophically fails. Such failures can have major consequences including equipment damage, operational downtime, injury, or death.

Figure 1

How to Prevent Metal Fatigue?

Metal fatigue can result from friction, impact, loading, corrosion, or temperature extremes. Failure typically occurs when tensile strain exacerbates a defect beyond the fatigue strength of the component. A common approach to preventing fatigue failures is by adding compressive residual stress to the material. Compressive stress inhibits fatigue cracking and provides internal resistance against tensile strain. There are several established methods for imparting compressive residual stress: shot peening, laser peening, deep rolling, ultrasonic impact, and burnishing.

The Laser Shock Peening Process

Laser shock peening is a targeted application designed to provide strategic enhancement at critical failure points. The process takes place in an enclosed production cell with a robotic arm to manipulate the target component. Laser peening requires three basic elements:

- A specialized laser to deliver a short, high-energy pulse
- An opaque overlay material to absorb the laser energy
- A transparent overlay to confine the resulting plasma burst

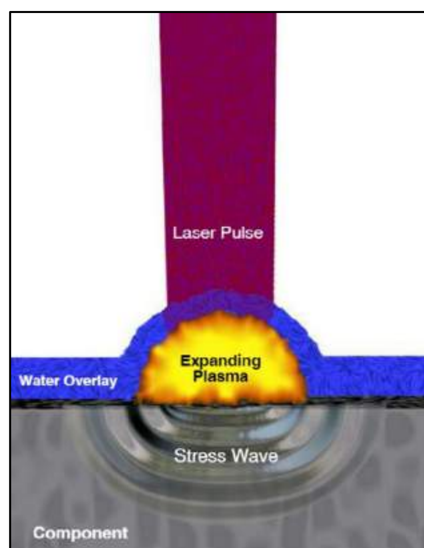

Figure 2

First, the target area is covered with an opaque overlay material, typically an adhesive or oily liquid. A high-energy laser pulse strikes the target, vaporizing the overlay and superheating it into a rapidly expanding plasma. A thin layer of water confines the plasma against the part surface, generating a powerful shockwave that propagates into the material. The process is repeated across the target area, reshaping the subsurface microstructure and producing a field of deep compressive residual stress.

Laser Shock Peening Benefits

Laser peening improves metal fatigue resistance and damage tolerance, extending component lifetimes and preventing costly failures. Laser peening produces deeper compressive residual stresses than other surface enhancement treatments, delivering fatigue life extensions up to 10X.

Laser Shock Peening Applications

Figure 3

Laser peening works on a variety of metals and alloys, including:

- Titanium
- Aluminum
- Nickel
- Steel

Laser peening enhances critical parts for a variety of industries, including:

- Aerospace – Engine components, wing attachments, landing gear, brakes
- Power generation – Turbine blades, nuclear reactor welds
- Heavy machinery – Crankshafts, cylinders, bearings, connecting rods
- Maritime – Ship hulls, welded joints, propulsion systems
- Manufacturing – Tooling and dies

Further Resources

1. Video: Laser Shock Peening in Action
2. Case Study: Laser Peening Prevents Engine Blade Damage in Aircraft
3. Beneath the Surface: How Laser Peening Generates Residual Stress

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FIVE AMAZING FACTS ABOUT LASER PEENING

Laser peening is a fascinating marriage of electromagnetic physics and materials science. The process uses high-energy lasers to strengthen metals, producing **robust components** that are resistant to failure. Laser shock peening (LSP for short) plays a critical role enhancing critical parts for critical industries. You'll find laser peened parts in aircraft engines, power plants, and heavy machinery around the world.

If you're new to laser peening, we've got a wealth of technical content available at your fingertips. (Check out our library of papers and patents!) But before taking that deep dive, here are five interesting facts to put this revolutionary enhancement process in perspective.

1) LIGHT CAN STRENGTHEN STEEL

It's worth taking a step back to consider the awesome implications of enhancing metal with lasers. We're using pulses of light to strengthen steel and titanium, replacing old-world peening techniques with new-age technology.

It used to be done with hammers. The rounded head of a ball peen has long been used by blacksmiths to pound and shape forged components. These brute-force blows put compressive stress into tools and armor, but their benefits weren't fully realized until a budding auto industry adopted shot peening to strengthen axels and springs.

Metal enhancement has come a long way

Shot peening is another brute-force enhancement method using high-velocity impacts to generate compressive residual stress. The process requires thousands of pellets or particles, launched toward a workpiece to produce a thin accumulation of surface compression. It's messy and imprecise, and the benefits extend just fractions of a millimeter beneath the surface.

Laser peening transcends these old barrage-based methods, taking surface enhancement into the twenty-first century. Coherent photon pulses impart compressive stress **many times deeper** than hammers or pellets could ever achieve. With all due respect to the burly blacksmiths of old, laser peening has moved metal enhancement out of the dark ages with brilliant blasts of light.

2) PLASMA DOES THE WORK

So how does light generate a force in solid metal? The secret lies in the power of plasma – the same stuff stars are made of. Plasma is an ionized gas of positive and negative particles, and it's generated with every pulse in the laser peening process.

Other sources of plasma: stars, lightning, atmospheric auroras

Laser peening delivers intense energy to a component surface for just a few billionths of a second. This quick burst of irradiance vaporizes a small amount of overlay material, and the vapor absorbs so much energy that the atoms themselves are ripped apart. The superheated plasma expands rapidly, generating a shock of pressure that sends a compressive wave into the part surface. The shock wave does the work of plastic deformation within the metal, and the resultant residual stress **fortifies the part against cracking and fatigue.**

In a way, laser peening could also be considered plasma peening. The laser generates plasma, which generates a shockwave, which produces compressive stress. It's a beautiful cycle translating light energy into mechanical work.

3) IT'S ALL MECHANICAL

Many people assume laser peening is a thermal process. Lasers are often associated with heat, and there are many thermal laser processing methods like cutting, welding, and cladding. Many 3D printing techniques also use thermal lasers to melt or fuse particles, and doctors may employ laser-generated heat for tissue cutting and removal.

Laser peening differs from these thermal treatments in that it's actually the **mechanical shockwave that works beneath the metal surface.** LSP is tailored to generate a pressure pulse via rapidly expanding plasma. The plasma is hot, but it's not the heat that alters the material, it's the pressure generated on the surface as the plasma expands.

So how is all that energy directed into the metal? The answer is surprisingly simple.

4) A LITTLE WATER GOES A LONG WAY

For all the sophisticated engineering and equipment involved, you might not expect that the secret ingredient for laser peening is ordinary water. Simple though it may seem, water acts as a crucial confining medium for the expanding plasma, amplifying the shockwave and directing the pressure pulse into the target workpiece.

Laser peening technicians call this the **“transparent overlay”**. It’s applied in a thin layer over the part surface, allowing the laser pulse to pass through but confining the resultant plasma burst for maximum amplification. Without a transparent overlay, the plasma would mostly blow off into the air, producing negligible results in the target metal. The water acts as a tamping mechanism, holding the pressure against the part surface and sending the shockwave where we want it – into the material.

And when that water is doing its job, the part will feel it. Laser peening generates a shockwave that propagates far deeper than any other surface enhancement technique.

5) THE BENEFITS RUN DEEP

Superior part protection is all about deep compressive residual stress. These beneficial internal stresses offset the damaging tensile strain that leads to component cracking and failure. Fatigue life improvements are directly proportional to the magnitude and depth of induced compressive stresses – metrics by which **laser peening dominates competing surface technologies.**

As mentioned earlier, shot peening produces compressive stress a few tenths of a millimeter beneath the surface. The application is limited by the kinetic energy of the shot media, and it’s impossible or impractical to generate stronger shockwaves through shot impacts alone. Laser peening provides the advantage of tremendous targeted energy via a powerful laser. This energy density produces a high-amplitude compressive wave that propagates deep beneath the material surface.

As a result, average laser peening depths exceed those of shot peening by an order of magnitude. Laser peening routinely produces compressive stresses 1-2 millimeters in depth, and the process has reached as deep as 12 millimeters. Nearly half an inch! These deep compressive stresses give laser peened parts serious fatigue resistance, **extending component lifetimes as much as 20X**.

In summary, laser peening is a complex process with a simple goal: make metals stronger so important parts don't fail. From light pulses to plasma bursts to powerful compressive waves – the nuances of laser peening make for fascinating science and formidable results.

LSP Technologies

The Ballad of Clay Moore
Eric S. Hoffman, 2022

I'm walking in a dream.

Nothing feels real.

Not the land. Not the sky. Just the pain.

The pain feels real.

Baxter and I stagger through a broken landscape. Dead grass. Scorched earth. Smells like sulfur and rust.

I call out for my wife, but my voice won't carry. Baxter calls too. Maybe we're doing this wrong.

"Come here, boy." I bring the bloodhound to my side. "Can you find Ashley? Pick up her scent?"

He looks at me with those honest eyes. Wants to help, but he doesn't understand. Could he smell her in this mess? We have to try.

I fumble around my pockets for a scrap of Ashley's scent. Lighter and smokes. That won't do. Dig into another pocket and strike gold: An old hankie.

Two nights ago (was it?) Ash was getting ready for bed and putting on her favorite cream. Rosehip. She hit a bubble and the tube barfed all over. Boy, was she mad. Wiped the waste on this hankie and handed it to me.

"What do you think, boy?"

I hold it out for Baxter and his tail starts wagging. Now he knows.

"Go find Momma!"

The old hound barks and sticks his nose in the dirt. Takes a taste of the wind and takes off. Bloodhounds, man. They can tease a week-old trail and track it for miles. Always blows my mind. Not just the hound's huffing power, but the fact that we all leave that kind of trace. Some essence off my ass that just hangs around for days. Old hound comes by like: "Yup, that's Clay."

Baxter never had the discipline of a working dog, but tracking Ashley ought to be cake. I say a little prayer and try yelling again.

"Ashley!" My call hangs flat in the quiet morning. I look down and see half a rabbit. Fight the urge to throw up.

"Ashley!"

She can't be far.

"Ashley!"

Deliver me, Bax.

"Ashley!"

And then he does.

Two quick woofs from up ahead. I stumble to his side, afraid of what I'll find.

A body in the dust. Purple silk. Face down.

She's dead.

Oh, God.

My heart goes cold. My eyes roll up.

I choke on rage and anguish and pain.

Who did this? How could you?

I want to scream at the Lord.

I want to rip the world in half.

I want to pull down the stars and set fire to the sky and-

She moves.

She moves!

"Ashley!"

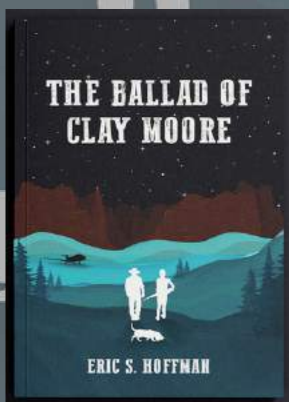
I drop to my knees and feel my wife for warmth. She's covered in dust and dried blood. I roll her over and she squints through crusty eyes.

"Ashley..."

I weep with joy. We're a family again. Ashley mumbles something, but I can't make it out. I pull her close and smell rosehip. Wipe a tear off her cheek.

"Water," she whispers through dry, dusty lips.

I lean in and kiss her, 'cause for now that's all I've got.



Popular Chess Openings

Ruy Lopez

1. e4, e5; 2. Nf3, Nc6; 3. Bb5

- Rapid development
- Easy to castle
- Great for beginners

Sicilian Defense

1. e4, c5

- Asymmetrical
- Countless variations
- Fight for the center
- Black plays to win

Queen's Gambit

1. d4, d5; 2. c4

- Creates early pressure
- Space to develop
- Learn to plan ahead

King's Indian Defense

1. d4, Nf6; 2. c4, g6

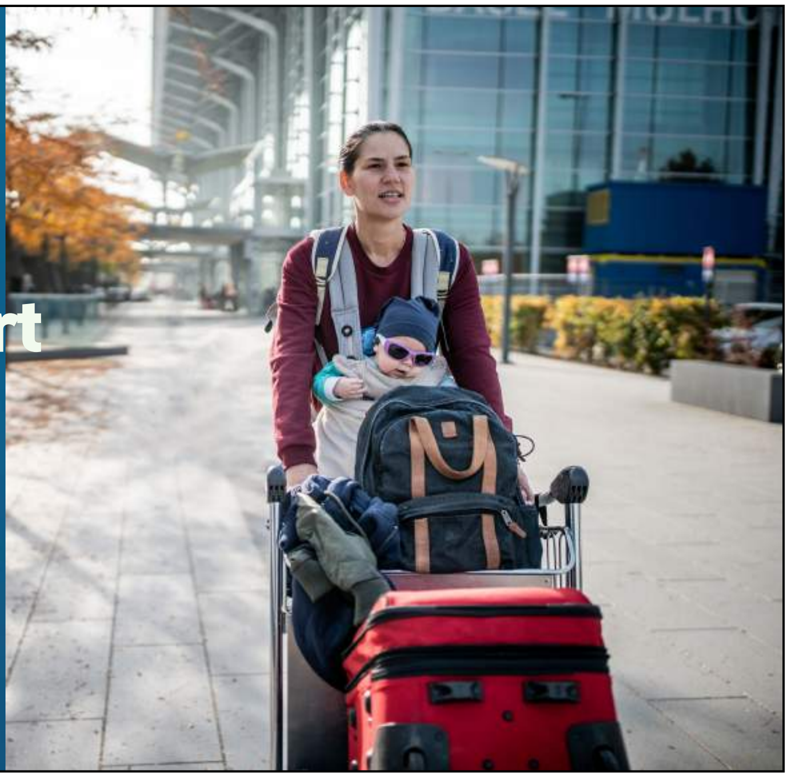
- Flexible and fun
- Bishop fianchetto
- Attack from the flanks

Each chess opening is a door to a dynamic game. Learn the fundamentals and improve your play. Most importantly: have fun!

Created with Canva by Eric S. Hoffman

Expat Guide: Consular Report of Birth Abroad

Presented by Eric S. Hoffman



Highlights

- What is a Consular Report of Birth Abroad?
- What forms and documents do you need?
- What about passports and Social Security cards?
- Helpful resources and links

How does a child born outside the United States acquire citizenship?

A U.S. citizen parent may apply for a Consular Report of Birth Abroad (CRBA). A CRBA is an official document recognizing the child's claim to U.S. citizenship.

A CRBA identifies the child as a citizen **at birth**, and an application can be made any time before the child turns 18.

A CRBA is issued by the United States embassy or consulate in the country where the child was born.

Who is eligible for a CRBA?

- Child must be under 18 at the time of application.
- At least one parent must be a U.S. citizen who lived previously in the United States.
- If the parents are unmarried, the U.S. citizen parent must submit an additional form pledging financial support.

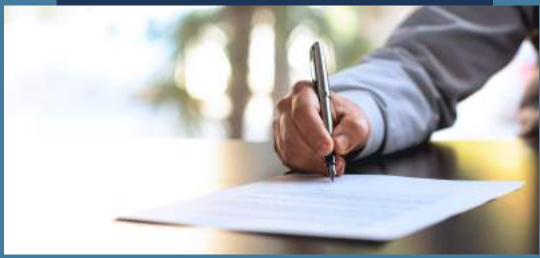
Form DS-2029

- This is the core application for a CRBA.
- Download from the State Department website or contact your local embassy.
- Provides thorough instructions and collects relevant information about the parents and child.

Download form DS-2029:
https://eforms.state.gov/Forms/ds2029.PDF

WARNING!

Do not sign the form at home!
Signing must be done in the presence of a consular officer.



Required Supporting Documents

Child's Birth Certificate

Some countries may require a translated version. Check with your local embassy.

Proof of Parent's Citizenship

- U.S. Passport
- U.S. Birth Certificate
- Parent's CRBA
- Naturalization Certificate

Evidence of Termination of Previous Marriages*

- Divorce decree
- Annulment
- Death certificate

*If applicable

Proof of Physical Presence in the U.S.

See next slide.

Be prepared with originals and photocopies.

Physical Presence in the United States

Parents conferring citizenship must demonstrate a period of prior physical presence in the United States.

Requirements vary based on conditions of marriage, so check the state department website for full guidelines.

Acceptable Documents Include:

- Academic transcripts
- Wage and tax statements
- Formal letters from employers
- Rental receipts and utility bills
- Travel documents including expired passports

Passport and Social Security Card

Many parents apply for their child's CRBA in conjunction with a U.S. passport and Social Security Card. Each requires an additional form.

U.S. Passport Application

- Form DS-11
- Two 2x2 inch photos

Social Security Card Application

- Form SS-5-FS
- Submit to regional SS office

A Consular Report of Birth Abroad (CRBA) is an invaluable tool to ensure your child enjoys all the benefits of U.S. citizenship.

Find more information at the links below:

State Department Guidelines - CRBA
https://travel.state.gov/content/travel/en/international-travel/while-abroad/birth-abroad.html

Online Passport Application
https://pptform.state.gov/

Social Security Administration - International Operations
https://www.ssa.gov/foreign/

Find Your Embassy
https://www.usembassy.gov/

Eric S. Hoffman

Writer

In 2018, I built a website to document my life and travels abroad. I lived in Malaysia for three years and experienced a whirlwind of cultural immersion. Below are links to a few of my favorite stories.

MALAYSIA, HERE I COME

A BABY ABROAD

THE HORRORS OF DURIAN

BALIK KAMPUNG: MALAYSIAN VILLAGE LIFE

THE LONGEST DAY: OUR TRIP AROUND THE WORLD

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