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DISCOVERING MARS, ONE SAMPLE P. (AT A TIME

I, (XRD) ROBOT Automation in x-ray diffraction



FROM THE TEAM a magazine produced by PROTO

It's hard to believe another year has gone by and we are publishing our second issue of 2Theta magazine. The support and interest have been overwhelming, and we have our entire PROTO family to thank for that. And to you, our readers – thank you for all of your submissions and suggestions for our second issue. This issue features an article about the use of XRD on Mars and highlights Dr. Roberta Flemming's research group and their work with future Mars-bound rovers. We welcome any submissions or suggestions for upcoming issues and encourage you to reach out to us at any time at 2theta@protoxrd.com.





A magazine highlighting x-ray diffraction and its application in science and engineering.



THE SCOOP What's happening around PROTO

NEW & NOTABLE Recent innovations to the product line



DISCOVERING MARS, ONE SAMPLE AT A TIME A look at the use of XRD on Mars-bound rovers

3D PRINTING & RESIDUAL STRESS X-ray diffraction is helping to advance the use of metal 3D-printed parts

Automation in x-ray diffraction

ACROSS THE GLOBE A traveller's guide to some of the latest gadgets

WHERE IN THE WORLD IS CARMEN BRAGG-BRENTANO?

An inside look at one of our most seasoned travellers and his experience in Wroclaw, Poland

RIGHT BRAIN UNLEASHED The artistic side of PROTO



#FUNSCIENCE When you need a break from the lab







THE SCOOP what's happening around PROTO



With the recent expansion of PROTO's training programs, courses are offered for all levels of knowledge, both onand off-site. Custom courses are available in theoretical, practical and field training.

It's been quite a year at PROTO, and with 2019 moving forward at a fleeting pace, it's no surprise there are already plans for even more development. With impressive growth across all product lines, there also became a clear demand for training programs and courses in the field of x-ray diffraction. PROTO's team of application scientists have worked together to design custom training programs that meet the needs of industry professionals at every level. Whether you are looking for an introductory course on residual stress or more advanced field training, there are programs to fit all levels of knowledge and experience. All of

PROTO's courses aim to teach participants everything they need to know about x-ray diffraction and provide one-on-one training in a small classroom setting. Courses are offered at all of PROTO's offices and can also be arranged to take place off site to meet the scheduling needs of clients. The training programs are taught by experts in the field that have many years of experience in x-ray diffraction and are excited to share their knowledge and experience with those wanting to learn.

MXRD ULTRA-PORTABLE

This ultra-portable residual stress measurement system fits into a convenient travel case. Its dual x-ray detectors and full range $sin^2\Psi$ goniometer ensures full compliance with ASTM E915, EN15305, and JSMS-SD-10.

AXRD-LPD HR DIFFRACTOMETER

The AXRD-LPD is now available in a high-resolution diffraction option. Analyze your thin films and single crystal materials. Highly customizable to ensure the best XRR. RSM, and rocking curve data.

LAUE-HT BACK-REFLECTION

This patent-pending Laue back-reflection camera that PROTO has developed is revolutionary for Laue single-crystal orientation. This new technology allows images to be captured using a single camera without the presence of a shadow in the image.

NEW & NOTABLE recent innovations to the product line

DISCOVERING MARS ONE SAMPLE AT A TIME.

THE VARIOUS LIFE-FORMS THAT MAY HAVE LIVED ON MARS CAN ALSO BE HYPOTHESIZED BASED ON THE TYPES OF ROCKS FOUND ON MARS. **!!**

Mars is one of the most talked about and researched planets in our galaxy; humankind's curiosity about the possibility of life outside of Earth is a driving force behind the efforts. Given that a human mission to Mars seems to be inevitable in the future, it is important to do as much research

in advance to be best **FF** HUMANKIND'S CURIOSITY prepared for what may come. Orbiters give us global-scale views with information such as topography, chemistry, navigation,

and other planetary observations; however, a lander is required to facilitate the collection of finer details. This would provide the opportunity to gain an understanding of the geological history of the planetary body, the current condition of the surface and if there is any life present. Landers need to be equipped with the appropriate instrumentation to answer these questions.

The old saying that "a picture is worth a thousand words" or "seeing is believing" means that

images and imaging techniques are often ABOUT THE POSSIBILITY the first prioritized OF LIFE OUTSIDE OF sources of evidence EARTH IS A DRIVING FORCE acquired by a lander. BEHIND THE EFFORTS. **!!** Chemistry comes in at a close second, but by

> itself, chemistry does not always give a complete picture of the geological history of an area. Fortunately, the crystallography (specific arrangement of the atoms in crystalline solids) of

a geographical area can indicate the chemistry, temperature, and pressure of formation. When minerals form, they solidify into different crystallographic forms. Some minerals can even indicate the relative humidity and temperature of the environment in which they are situated. Using crystallography to learn about rocks helps shed light on both long-term, and short-term geologic (even cosmologic) processes. The main tool used to understand crystallography is x-ray diffraction (XRD), and for this purpose, the Mars Science Laboratory (MSL) Curiosity lander (a rover), that landed on Mars in 2012, was equipped with CheMin: a transmission XRD instrument with limited x-ray fluorescence capabilities.

MARS' POTENTIAL FOR LIFE?

Equipped with wheels, Curiosity was able to crawl across the surface of Mars and collect soil samples from different locations, passing them to the onboard CheMin instrument for analysis. Some of the initial Martian soil tested had a similar composition to soils found in Hawaiian volcanoes. In 2013, CheMin sampled rocks that contained clay minerals that are typically known to be the product of a reaction between fresh water and igneous minerals. This rock actually looks grey, rather than the typical red, as it is not fully oxidized and, as such, has the potential for being a source of energy for mirco-organisms. The various life-forms that may have lived on Mars can also be hypothesized based on the types of rocks found on

Mars. The CheMin XRD instrument is still proving valuable information to better understand Mars. As such, it is expected that future landers will also be equipped with XRD instruments.

GOING TO THE RED PLANET.

Dr. Roberta Flemming is leading a group of researchers from Western University's Department of Earth Sciences and the Centre for Planetary Science and Exploration, Brock University, and the University of Guelph, to create an even more advanced XRD instrument for future landers. "The Curiosity Rover on Mars crushes rocks into a powder, destroying critical information about the relationship between the minerals in the rock. Minerals tell us the story of the planet's geological history," says Flemming.

Flemming recognized the need for a better instrument and was recently funded by the Canadian Space Agency (CSA) to work on the development of a miniaturized *in situ* XRD (ISXRD) instrument. For the duration of the 18-month study, Flemming and her team from Western will be working with

Martian-analogue rocks, minerals, and meteorites to test candidate miniaturized x-ray components and geometries made at PROTO.

The ISXRD instrument aims to eliminate the need for grinding and sifting, as these additional processes can cause the investigated sample to sometimes not be representative of the rock from which it actually came, which can affect the integrity of the results. This new XRD instrument also aims to have less motor movement and incorporate more effective detector technology to improve upon the current Martian XRD capabilities.

ABOVE: Dr. Roberta L. Flemming, Ph.D., Associate Professor at Western University (Dept of Earth Sciences)

3D PRINTING & RESIDUAL STRESS

X-ray diffraction is helping to advance the use of 3D printed metal parts by ensuring they have the same fatigue resistance as their traditionally machined counterparts.

3D printing is revolutionizing how we create products. For a few hundred dollars, we can now buy printers that can print plastic 3D models, which can help us conceptualize ideas and in some cases, these models can even be used as working devices. More advanced printers available for as low as \$10,000 can be used to print carbon fiber and form very solid and reliable parts. Many small parts that used to be machined are now

reliably made using these carbon fiber printers. Small items such as brackets, couplers, small mechanical gears, and covers can be made quickly and cost effectively. Parts can be printed in a few hours and files can be sent directly to the printer from a 3D drawing. reducing the amount of work required for the design.

Additionally, 3D printing gives a designer more freedom by permitting much more complicated designs to be manufactured than would be traditionally allowed. The constraints of figuring out how to construct a part using the equipment in a machine shop are removed.

For the price of a CNC machine (approx. \$100,000), it is even possible to get a printer capable of printing metal parts. Metal 3D printing is a very exciting method for the manufacturing industry, as it can replace complicated processes such as casting or machining. It also has the potential to be used to create replacement parts on demand. When considering using

a metal 3D-printed replacement part, it is important to understand that while the part may be dimensionally the same as a machined part, the final chemistry, microstructure, and the internal stress (residual stress) may be completely different.

Residual stress affects fatigue life. So, careful control of it is necessary

to ensure that a part does not fail prematurely during use. In particular, compressive stress is generally beneficial to a part and helps keep cracks closed, slow down crack

propagation, and delay failure. X-ray diffraction is a common method used to measure the residual stresses present in the part after fabrication; dedicated residual stress diffractometers are used for this purpose. The part is placed in the diffractometer, and the angle of the diffraction peak can be used to determine if the material is under strain. As the strain changes in the material, the diffraction peak will shift up or down in angle depending on whether the part has compressive or tensile stress present. The scan typically takes a few minutes. The strain can then be converted to a stress, which is then evaluated to determine whether additional processing, such as heat treatment or shot peening, is required to modify the residual stresses.

that 3D-printed parts can often have very different residual stress than their traditionally machined counterparts. As a result, XRD is proving to be a valuable tool to ensure that 3D-printed parts are as safe and reliable as machined parts and can act as suitable replacements.

Residual Stress vs. Depth for 3D-Printed Parts Made From Different Metals

When most of us think of robots, we tend to think of large industrial robots that assemble parts inside a factory, performing such tasks as welding cars, assembling electronics, or sorting and inspecting parts. Having the ability to repeat the same task without a break for 24 hours per day, robots have proven to be an ideal way to increase efficiency and part consistency. As computing power has increased, more complex situations can now be analyzed on the fly, allowing robots to work on applications that, until recently, required a human to do.

Historically, robots also had to be operated inside a safety cage, to prevent injury to humans. The newer collaborative-style of robot has built-in safety systems that allow the robots to operate out in the open rather than in the confines of a cage. Sensors detect when the robot comes into contact with an object and safely stops the movement, preventing harm to both humans and objects.

The ability to operate robots safely near humans has resulted in robots being used in areas of our life that are much more visible. Some stores are now using robots to help stock shelves: they roam the aisles looking for missing items on shelves and; send a message to a computer to restock or re-order these items. We are seeing robotic dispensing systems inside pharmacies, and even robotic chefs and bartenders.

Recently, in the x-ray diffraction world, robots have been integrated into more and more projects. Three particular uses are: robots acting as a goniometer, robotic sample handling systems, and collaborative robots working side by side in a lab with technicians.

Newer robots have enough accuracy, that, with the appropriate error-tracking

system, they can move in a concentric circle and act like a goniometer. PROTO has recently been mounting x-ray tubes and detectors directly onto robots and using a robot to measure residual stress. The ability to move a robot around a large sample is proving to be of great interest for customers with large samples who need multiple locations to be analyzed. In high-throughput testing applications, such as PROTO's Laue product line (used for orienting industrial grown crystals), robots are proving to be very valuable handling systems. In a new diamond marking system produced by PROTO, the robot can pick up the diamond, collect the Laue image, determine the orientation of a specific crystal face, and then present the diamond to a laser for etching lines into the side of the diamond. These lines can then be used in a subsequent cutting step, to enable any crystallographic face

to be exposed from the diamond. After processing, the diamond is returned to the operator. This set of procedures would be extremely difficult to do accurately or quickly without the use of a robot. This ability to use a robot as a highly accurate measurement technician, not only helps improve measurement accuracy, but also can also be implemented at a price point that is very reasonable.

ABOVE: Robotics handling system for orienting diamonds before cutting

ACROSS THE GLOBE

an inside look at travelling with the PROTO team

COOL TRAVEL GADGETS

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STEAMFAST TRAVEL STEAM IRON

This travel-sized steam iron has convertible voltage making it great for traveling overseas, while the vertical steam allows you to steam hanging clothing with ease.

RECOMMENDED BY: Matt Williams, Physicist

"This is awesome for getting pesky wrinkles out of dress shirts and can even be used on booth displays."

CAMELBAK ALL CLEAR

State-of-the-art device capable of transforming almost any tap or clear natural water source into pure drinking water in just 60 seconds

RECOMMENDED BY: Kriss Leftwich, Application Scientist

"This has been a great tool ensuring that I always have safe drinking water, regardless of what region I'm visiting"

TUMI 4-PORT USB TRAVEL ADAPTOR

This conveneient adaptor supports outlets from 150 countries. You can charge up to four devices at once, and weighs only 8 oz.

RECOMMENDED BY: Natan Caratanasov, Service Manager "Being able to communicate with my team and customers is important. This adaptor has helped me stay connected."

WHERE IN THE WORLD IS CARMEN BRAGG-BRENTANO?

Our sales and service teams travel all of the world. We asked Carmen, our most destinguished team member, to tell us about his recent visit to Wroclaw, Poland.

I only had a short time to experience one of Poland's most historical cities, but I made the most of my time there. A quick work trip transformed itself into memorable

snapshots that would capture my love for a beautiful city. Though I only visited the Old Market Square in the city's centre, and the University of Wrocław, there was enough time to enjoy drinks, food, and good times in between. Wrocław is home to so much history, and although the Old Market Square was completely destroyed in the war, it was recently rebuilt in the same style, captivating tourists from all over the globe. While I drank delicious Polish beer, I indulged in platters of pierogis and sausages; and got to see the majestic City Hall lit up at night. While I still felt a little jet-legged on my way to the University of Wrocław the next day, it was well worth it for the memories I now have.

#3

ABOVE: Renaissance Center From Dieppe Park Windsor, Watercolour and Ink on Paper

LEFT: Cosmos, Acrylic on Canvas

RIGHT: Fragments of Aurora Borealis, Acrylic on Canvas

RIGHT BRAIN UNLEASHED

The artistic side of PROTO

James Pineault has shown his passion for his career by dedicating 28 years as the XRD Laboratory Manager at PROTO. His talent and passion continue in a completely different form when he leaves his desk, transforming into a world-class artist with both acrylic and watercolour works shown in galleries and shows across the region.

#FUNSCIENCE

when you need a break from the lab

A YEAR OF DISCOVERY

some of the most interesting & strange discoveries of 2018

A NEW SPECIES DISCOVERED

Thiolava veneris (Venus Hair), a new colonizing bacterium with long, hair-like structures, formed a white mat across half an acre of sea bed off the coast of El Hierro in the Canary Islands. After a submarine volcano wiped out morst of the marine life in 2011, scientists have discovered this new species and identified it as having characteristics that will pave the way for development of early-stage ecosystems.

GROUND-BREAKING DISCOVERY

On July 25, 2018, the Italian Space Agency announced researchers discovered an underground lake on Mars. Using ground-penetrating radar, the Mars Advanced Radar for Subsurface and Ionosphere Sounding instrument (MARSIS), uncovered a potential subglacial lake that is roughly 12.4 miles wide and three feet deep.

Photo: ESA/NASA/JPL/ASI/Univ/Fair Use

© Miguel Canals, University of Barcelona, Spair

LIGHTING THE WAY TO HEALTH

Researchers have found a way to fight the flu, by killing viruses with UV Light. A new study published in 2018's February issue of *Scientific Reports* reports that far-ultraviolet C (Far-UVC) light can kill flu viruses. The study suggest that use of Far-UVC light in highly populated areas like hospitals, schools, and airports could drastically reduce flu infections.

<u>Across</u>

US city musical
Office appliance
Moon element
Middle Kingdom
God of Love plant
Man's best friend
One lump or two?
Zloty country
God of War
Danger Will Robinson speaker

CROSSWORD

<u>Down</u>

- 2. Type of paint
- 4. QCx2-to-NYx2 dir.
- 5. Earth element
- 7. Quicksilver
- 8. Death of the cat cause
- 9. NASA program
- 14. One hump or two?
- 16. Coherent ray machine
- **18.** #9 club

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