FORCON
INTERNATIONAL

WILLIAM (BILL) DOUGLAS MACDONALD, PhD, P.E.

SUMMARY

Mr. MacDonald is an established technical professional with over 38 years of experience in the materials and metallurgical engineering industry. With applied in-depth knowledge to R&D, technical and business development across aerospace, industrial, chemical, oil and gas and automotive industries. Worldwide project experience in North America Europe, Asia and South America related to materials quality and specifications. Mr. MacDonald is active on major technical materials committees as an officer or voting member including AMPP, ASTM, ASME and API. Bill has over the years a robust record of establishing and maintaining extensive contacts throughout the industry. He is experienced with forensic investigations related to material failures and experience in all facets of metallurgical characterization including microstructural evaluations and structure property relationships.

Over the years Mr. MacDonald, has had significant technical accomplishments in the following areas, including but not limited to:

- Investigation into hydrogen embrittlement failure on a nickel alloy determined fundamental cause
- Analysis of a jet ski explosion determined failure of replacement polymer fuel lines
- Examination of failed hot water tank identified loss of anodic protection
- Development of new titanium alloy requiring detailed materials investigations
- Publications and presentations on the metallurgy of a variety of alloy systems
- Experience with nickel and titanium alloy performance and failure mechanisms

EDUCATION

PhD in Metallurgy – Massachusetts Institute of Technology; Cambridge, MA; 1993

Master of Science in Metallurgical Engineering – Queens University; Kingston Ontario; 1986

Bachelor of Science in Metallurgical Engineering (Hons) – Queens University; Kingston, Ontario; 1983

REGISTRATIONS & CERTIFICATIONS

Registered Professional Engineer in the following States:

- Pennsylvania

Registered Professional Engineer in the following Countries

- Ontario, Canada

PROFESSIONAL ASSOCIATIONS

American Society of Mechanical Engineers

- Chair Materials Database and Data Analysis
- Vice Chair Section II Materials SG Non-Ferrous Alloys
- Technical Project Manager in Section VIII SG Materials

National Association of Corrosion Engineers

- Technical Committee Chair: TC 11 Materials
- Chairman of the Geothermal Scaling and Corrosion Symposium (2018-2019)
- Technical Paper Reviewer

American Petroleum Institute

- API 6A CRA Task Group PH Nickel Alloys
- API 5 CRA Tubulars

American Society for Testing and Materials
- B02.07 Non-Ferrous Alloys Chair
- B02 Main Committee Member at Large
- B10 Reactive Metals Committee Member

International Titanium Association
- Industrial Applications Committee

ASM International
- Active member since 1982 (Brandywine Chapter)
- Treasurer of Kingston Chapter 1986–1989

National Academy of Forensic Engineers
- Associate Member

CAREER HISTORY

FORCON International – Metallurgical Engineer
Providing forensic investigation analysis and expert witness services as it relates to his fields of expertise.

SPECIAL METALS CORP. – Director of Technical Sales
Key representative of Special Metals in relevant technical societies related to main industrial markets. Responsible for technical support for customers related to materials properties, specifications and quality issues. Determined metallurgical cause of hydrogen embrittlement in offshore applications related to microstructural defects. Experience with manufacturing issues that cause materials compliance issues including grain morphology and residual stress. Interacted with DOE national laboratories, including Idaho and Oak Ridge National Labs and industry organizations including Materials Technology Institute and Electric Power Research Institute.

BERWYN METALS LLC – Consultant
Provided failure analysis requiring metallurgical expertise and root cause investigation for subrogation as directed by Prof. Tom Eagar (dec.) of MIT. Technical consulting on magnesium development project based in India and Middle East, on a tungsten/molybdenum acquisition and other metals related opportunities. Experience with the full suite of materials characterization and examination equipment, including Optical, SEM and TEM, XRF, XRD, ICP, Leco and tensile, toughness, fracture and corrosion testing.

ONTARIO CONSULTING – Consultant
Provided technical and commercial services to the magnesium industry in the evaluation of Chinese manufacturers. Travelled independently throughout China to visit plant sites and meet with senior leaders of the local governments.

TITANIUM METALS CORP. (TIMET) - Director of Technical Sales
Provided technical advice on wide variety of commercial activities in aerospace and industrial markets, including chemical process industry, automotive, offshore, marine, airframe and aeroengines. Prepared and delivered presentations both at customers and conferences in North America, Europe and Asia. Position required a wide range of materials knowledge and experience to support customers. Developed and commercialized a new titanium alloy requiring R&D and pilot scale manufacturing. Responsible for materials properties and testing including basic mechanical properties, fracture toughness, fatigue, impact toughness and corrosion. Provided guidance to end users related to titanium corrosion issues, such as hydrogen embrittlement, in process equipment. Interacted with Timet's R&D facility to direct materials testing and characterization.

CANMET-MTL, NATURAL RESOURCES CANADA - Manager, Advanced Structural Materials for Vehicles
Responsible for the Automotive Program, the largest of the four major programs at the laboratory. The program had a research budget of $6.5M in direct spending and was affiliated with major automotive programs in the U.S., Europe and China, including Ontario's Auto 21 initiative. Role was to define the program, establish and grow contacts in the industry, secure and manage funding, report on developments and milestones to the Director General of the Branch. Developed extensive contacts with the steel industry in Canada and abroad. Experience with state-of-the-

art characterization equipment such as high resolution Scanning and Transmission Electron Microscopy and Focused Ion Beam SEM analysis.

TIMMINCO LIMITED – Manager (Technical Sales) & Director (Research and Development and Pilot Plant Production)
As Director R&D, was the first in the world to successfully demonstrate rotary extrusion (Conform™) of magnesium. Through 2001 to 2003, technical leader that successfully re-engineered a $40M casthouse incorporating a unique metal transfer system for Vertical Direct Chill casting of magnesium billet. Developed a continuous casting solution for master alloy and coaxially clad products. Technical expert on the properties and performance of magnesium alloys and manufacture. Conducted projects requiring detailed microstructural and mechanical property analysis of extrusion and forging alloys.

SHERRITT TECHNOLOGIES/WESTAIM CORP. – Scientist and Production Supervisor
Developed a unique and patented process based on microwaves to sinter specialty ceramics at temperatures with best-in-class material properties. Worked on multiple materials related research projects requiring advanced materials characterization including determination of the Wiebull modulus for quality control. Supervised a staff of over 15 and successfully developed an R&D project into a commercial business unit. Project was commercialized and continues to operate today under the ownership of a major tool manufacturer.

ALCAN INTERNATIONAL LIMITED – Research Engineer
General engineering exposure to the aluminum industry, including production of aluminum and manufacturing of commercial products at a large corporate research laboratory. Investigated precipitation reactions in Al-Li alloys and studied influence of texture on forming operations using advanced materials characterization techniques. Investigated structure-property relations in high Tc superconductors. Initiated production of superconductor oxide laser ablation targets for start-up company. Received a grant from Alcan to attend MIT as a PhD student.

ACADEMICS

UNIVERSITY OF ALBERTA – Engineering Lecturer (1994–1996)
Prepared and taught graduate and undergraduate courses in materials, including ceramics and materials processing.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY – Materials Consultant (1990–1993)
Prepared failure analysis reports for outside companies involving NDE, SEM and metallographic examination. Performed mechanical property tests and evaluation of corrosion behavior. Designed specific testing apparatus for several legal cases. Interfaced with numerous manufacturers regarding applications of materials to problem solving. Work conducted under the direction of Prof. Tom Eagar with hands on experience of optical, SEM, TEM and mechanical testing equipment.

HIGHLIGHTED PRESENTATIONS AND PUBLICATIONS

S. McCoy et. al., *"Hydrogen Stress Cracking Resistance of Precipitation Hardenable Nickel Alloys and Optimization"*, AMPP Annual Conference, Paper No. 20719 (New Orleans, LA, 2024)

McCoy, S. A., Damm, E. B., Baker, B. A., & MacDonald, W. (2023, March). *"The Combined Influences of Microstructure, Strength, and Titanium Content on the Hydrogen Stress Cracking Resistance of Precipitation Hardened Nickel Alloys."* In AMPP CORROSION Paper No. 19348 (Denver, CO, 2023)

W.D. MacDonald et. al., *"Evaluation of Titanium 475 Alloy for Use in Oil and Gas Environments"* AMPP Annual Conference, Paper 17840, (San Antonio TX, 2022)

McCoy, Stephen, Brian A. Baker, and William MacDonald. *"Optimization of Hydrogen Stress Cracking Resistance of High Strength Precipitation Hardened Nickel Alloys."* Paper No. 17960, AMPP CORROSION (Houston, TX, 2022)

W.D. MacDonald and M. Gram, *"Titanium Casing for High Temperature Wells",* Geothermal Rising Conference, San Diego, GRC Transactions, Vol. 45, 2021

W.D. MacDonald and J. Grauman, "*Development of New Titanium Alloys for Use in Aggressive Geothermal Environments",* Corrosion 2019, Paper No. 12871, (Nashville, TN 2019)

W.D. MacDonald and J. Grauman, "*Simulated Exposure Testing of R53400, R56404 and N06625 in Salton Sea Brine",* Corrosion 2018, Paper No. 11547, (Phoenix, AZ 2018)

W.D. MacDonald and J. Grauman, "*The Service History and Performance of Titanium in Geothermal Systems*", Corrosion 2014, Paper No. 3831, (San Antonio, TX 2014)

W.D. MacDonald and Y. Kosaka, "*Titanium: Rethinking the Value of Non-traditional Light Metals for Transportation",* CIM 2013, Montreal, Canada

Sager, C. A., Yakubtsov, I. A., MacDonald, W. D., Shook, S., Diak, B. J., & Niewczas, M. (2009). "*Physical metallurgy of Mg AZ80 alloys for forging applications*", Mater. Soc. Annu. Meet, 12, 405-410.

F. Ju, X. Zihui, B.J. Diak, O.A. Ojo, W.D. MacDonald, M. Niewczas, "*Modeling and simulation of Mg AZ80 alloy forging behavior"*, SAE World Congress, 2008.

I.A. Yakubtsov Diak, B.J., Sager, C.A., Bhattacharya, B., MacDonald, W.D., "*Effects of heat treatment on microstructure and tensile deformation of Mg AZ80 alloy at room temperature"*, Vol 496, pp 247-255, Mat.Sci. and Eng. A, 2008

Sediako, D., W. MacDonald, and S. Hibbins. *"Mould Thermal Analysis in Direct-Chill Casting of Magnesium Alloys"* The Minerals, Metals & Materials Society, TMS, New Orleans, LA, March 2008, Magnesium Technology 2008, 215 219 (2008).

W.D. MacDonald, "*Wrought Magnesium in the Transportation Industry"*, 17th Annual Magnesium in Automotive Seminar, April 2006.

Koushik, S.V., Jirjis, R., Plunkett, J., MacDonald W., *"Fine-tuning the process of liquid metal delivery to the casting centers"*, American Foundry Society. 2006

W.D. MacDonald, "*Wrought Magnesium Review: Properties and Selection Criteria for Lightweight Applications"*, International Magnesium Association Annual Conference, Montreal 2001.

W.D. MacDonald and T.W. Eagar, "*Isothermal Solidification Kinetics of Diffusion Brazing"*, Metallurgical & Materials Transactions A, 29(1), pp. 315-325, 1998.

P.S. Apte and W.D. MacDonald, "*Microwave Sintering Kilogram Batches of Silicon Nitride"*, Presented at the 74th Annual Am. Cer. Soc. Meeting, Cincinnati, March 1995.

W.D. MacDonald, G.J.C. Carpenter and S. Saimoto, "*Using Strain Rate Sensitivity Measurements to Determine Phase Relations in A430 Stainless Steel"*, Mat. Sci. and Eng., A190, pp. 33-42, 1995.

W.D. MacDonald and T.W. Eagar, *Transient Liquid Phase Bonding,* Annual Reviews of Materials Science, vol. 22, pp.23-46 1992.

E.G. Zwartz, B.A. Judd, E. Batalla, L.S. Wright and W.D. MacDonald, "*Silsbee rule in $YBa_2Cu_3O_7$ ceramic superconductors"*, Can. J. Phys. 67, pp. 614-16 , 1989. (Best Paper Award)

MacDonald, W. D., and S. Saimoto. *"Influence of Texture on Formability of 430 Stainless Steel Sheet."* ICOTOM: Eighth International Conference on Textures of Materials. Santa Fe, NM 1987.