



Exponent®

Engineering & Scientific Consulting

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## Professional Profile

Dr. Murray specializes in failure analysis and failure prevention of engineering materials, components, and systems. His specific expertise includes metallurgy, microstructure evolution, additive manufacturing, and high temperature materials testing.

Dr. Murray assists clients in understanding the underlying factors that have resulted in failed, fractured, and corroded components and systems, and how to make progress in preventing these failures from occurring in the future. This experience has consisted of direct-cause failure analysis of components to interdisciplinary investigations of engineering systems. His recent project experience includes failure analysis of fractured leaf-springs, railroad fastening equipment, solar panel junction boxes, leaking brazed joints, steel bolt fatigue failures, nitinol medical devices, sprinkler coating corrosion, and candidate alloy reviews. Dr. Murray has also supported clients in domestic litigation and international arbitration disputes.

Dr. Murray has an extensive background in materials characterization using a variety of analytical tools and techniques including metallography, electron microscopy, mechanical testing, CALPHAD modeling, differential thermal analysis, and oxidation testing.

Prior to joining Exponent, Dr. Murray was a Graduate Researcher at the University of California, Santa Barbara, where he received his Ph.D. in 2021. While there, he studied the high temperature properties of a novel class of precipitation strengthened CoNi-base superalloys. After identifying alloy compositions with promising high temperature properties, these alloys were demonstrated to be processible through additive manufacturing techniques such as selective laser melting and electron beam melting with low defect content. This is currently challenging for commonly used high strength Ni-base superalloys due to their susceptibility to cracking during additive manufacturing. This work involved grain-scale and precipitate-scale microstructural evaluation, microsegregation measurements, solidification modeling, and heat treatment development.

## Academic Credentials & Professional Honors

Ph.D., Materials, University of California, Santa Barbara, 2021

B.S., Materials Science and Engineering, University of Illinois, Urbana-Champaign, 2016

National Defense Science and Engineering Graduate Fellowship, 2017-2021

University Honors – Bronze Tablet, 2016

## Patents

US Patent Application 16/375,687: High temperature oxidation resistant Co-based gamma/gamma prime alloys DMREF-Co, May 2020. (Pollock TM, Stewart CA, Murray SP, Levi CG)

## Publications

Murray SP, Raeker EB, Pusch KM, Frey C, Torbet CJ, Zhou N, Forsik SAJ, Dicus AD, Colombo GA, Kirka MM, Pollock TM. Microstructure evolution and tensile properties of a selectively laser melted CoNi-base superalloy. *Metallurgical and Materials Transactions A* 2022; 53:2943-2960.

Rossin J, Leser PE, Pusch KM, Frey C, Murray SP, Torbet CJ, Smith S, Daly S, Pollock TM. Bayesian inference of elastic constants and texture coefficients in additively manufactured cobalt-nickel superalloys using resonant ultrasound spectroscopy. *Acta Materialia* 2021; 220:117287.

Murray SP, Cervellon A, Cormier J, Pollock TM. Low cycle fatigue of a single crystal CoNi-base superalloy. *Materials Science and Engineering: A* 2021; 827:142007.

Goodlet BR, Murray SP, Bales B, Rossin J, Torbet CJ, Pollock TM. Temperature dependence of single crystal elastic constants in a CoNi-Base alloy: A new methodology. *Materials Science and Engineering: A* 2020; 803:140507.

Murray SP, Pusch KM, Polonsky AT, Torbet CJ, Seward GGE, Zhou N, Forsik SAJ, Nandwana P, Kirka MM, Dehoff RR, Slye WE, Pollock TM. A defect-resistant Co–Ni superalloy for 3D printing. *Nature Communications* 2020; 11:4975.

Murray SP, Pusch KM, Polonsky AT, Torbet CJ, Seward GGE, Kirka MM, Dehoff RR, Zhou N, Forsik SAJ, Nandwana P, Slye W, Pollock TM. Microstructure and Tensile Properties of a CoNi-Based Superalloy Fabricated by Selective Electron Beam Melting. In S. Tin et al. (Eds.) *Superalloys 2020. The Minerals, Metals and Materials Series*. Springer.

Vamsi KV, Murray SP, Pollock TM. The Yield Strength Anomaly in Co–Ni Design Space. In S. Tin et al. (Eds.) *Superalloys 2020. The Minerals, Metals & Materials Series*. Springer.

Charpagne M-A, Stinville J-C, Polonsky AT, Echlin MP, Murray SP, Chen Z, Bozzolo N, Cormier J, Valle V, Pollock TM. Tuning Strain Localization in Polycrystalline Nickel-Based Superalloys by Thermomechanical Processing. In S. Tin et al. (Eds.) *Superalloys 2020. The Minerals, Metals & Materials Series*. Springer.

Charpagne M-A, Vamsi KV, Eggeler YM, Murray SP, Frey C, Kolli SK, Pollock TM. Design of Nickel-Cobalt-Ruthenium multi-principal element alloys. *Acta Materialia* 2020; 194:224–235.

Stewart CA, Murray SP, Suzuki A, Pollock TM, Levi CG. Accelerated discovery of oxidation resistant CoNi-base  $\gamma/\gamma'$  alloys with high L12 solvus and low density. *Materials & Design* 2020; 189:108445.

Murray SP, Stinville J-C, Callahan PG, Rhein RK, Pollock TM. Low Cycle Fatigue of Single Crystal  $\gamma'$ -containing Co-based Superalloys at 750 °C. *Metallurgical and Materials Transactions A* 2020; 51:200–213.

Rhein RK, Callahan PG, Murray SP, Stinville J-C, Titus MS, Van der Ven A, Pollock TM. Creep Behavior of Quinary  $\gamma'$ -Strengthened Co-Based Superalloys. *Metallurgical and Materials Transactions A* 2018; 49:4090–4098.

Goodlet BR, Mills L, Bales B, Charpagne M-A, Murray SP, Lenthe WC, Petzold L, Pollock TM. Elastic Properties of Novel Co- and CoNi-Based Superalloys Determined through Bayesian Inference and Resonant Ultrasound Spectroscopy. *Metallurgical and Materials Transactions A* 2018; 49:2324–2339.

Coppola AM, Warpinski LG, Murray SP, Sottos NR, White SR. Survival of actively cooled microvascular polymer matrix composites under sustained thermomechanical loading. *Composites Part A: Applied Science and Manufacturing* 2016; 82:170–179.

## **Presentations**

Murray SP, Pusch KM, Polonsky AT, Torbet CJ, Seward GGE, Kirka MM, Dehoff RR, Zhou N, Forsik SAJ, Nandwana P, Slye W, Pollock TM. Microstructure and Tensile Properties of a CoNi-Based Superalloy Fabricated by Selective Electron Beam Melting. Oral Presentation, Superalloys 2021, Virtual, 2021.

Murray SP, Cervellon A, Cormier J, Pollock TM. Low Cycle Fatigue of Single Crystal Co- and CoNi-base Superalloys: The Role of Oxidation Resistance. Oral Presentation, TMS 2021, Virtual, 2021.

Murray SP, Pusch KM, Polonsky AT, Torbet CJ, Seward GGE, Kirka MM, Dehoff RR, Zhou N, Forsik SAJ, Nandwana P, Slye W, Pollock TM. Microstructure and Mechanical Properties of a CoNi-base Superalloy Fabricated by Electron Beam Melting. Oral Presentation, TMS 2020, San Diego, CA, 2020.

Murray SP, Stinville J-C, Callahan PG, Rhein RK, Pollock TM. Low Cycle Fatigue of Single Crystal  $\gamma'$ -Strengthened Co-based Superalloys. Oral Presentation, TMS 2019, San Antonio, TX, 2019.

Murray SP, Rhein RK, Callahan PG, Stinville J-C, Titus MS, Van der Ven A, Pollock TM. Creep Behavior of Quinary  $\gamma'$ -Strengthened Co-base Superalloys. Oral Presentation, Eurosuperalloys 2018, Oxford, UK, 2018.

Murray SP, Stewart CA, Suzuki A, Pollock TM, Levi CG. Discovery and Design of a Novel Cobalt-Nickel-Based Superalloy. Oral Presentation, STIX 2018, U.S. Institute of Peace, Washington D.C., 2018.

Murray SP, Stewart CA, Suzuki A, Pollock TM, Levi CG. A Novel CoNi-based  $\gamma'$ -strengthened Superalloy with Elevated  $\gamma'$  solvus and Desirable Oxidation Behavior. Oral Presentation, ACEEES 2017, Tenerife, Canary Islands, Spain, 2017.

## **Peer Reviews**

Metallurgical and Materials Transactions A

International Journal of Fatigue

Journal of Materials Science

JOM