



Fall 2020 Semi-Annual Meeting
October 13-15, 2020
Virtual Meeting

Welcome to Zoomland!



- Please mute yourself unless you are speaking
- Please use the chat function to queue/ask questions
 - Messages to everyone
 - Messages to specific attendees
- Raise your hand if you'd like to speak
- Speakers please use your laser pointer function
- Let us know via chat if there are sound or image issues...

Welcome to Zoomland!



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Zoom Meeting ID: 551-937-9395

Participants (2)

- KC Kester Clarke (me)
- KD Kester D Clarke (Host)

Mute/unmute

Mute/unmute

Raise Hand

Video on/off

Menu: Clap, Away, Break

Unmute Me

Unmute Start Video Invite Participants Share Screen Chat Record Reactions Leave Meeting

To: Everyone Type message here...

Introductions



- Name (we'll call on you)
- Affiliation (if applicable, briefly what your company is interested in)

Registered Attendees from Sponsor Companies and Visitors



Registered Attendees

<u>Member Company</u>	<u>Representatives</u>
Air Force Research Laboratory (AFRL)	Todd Butler Matthew Krug Eric Payton Lee Semiatin
ATI	Anthony Banik Matt Bender John Foltz Sabrina Nacer-Meck Noah Philips Kevin Severs Jennifer Shelton Kathryn Weyeneth
The Boeing Company	Paul Wilson
DePuy Synthes	Scott Bingham
Elementum 3D	Jeremy Iten
Honeywell	Daira Legzdina
Lawrence Livermore National Laboratory (LLNL)	David Loyola
Los Alamos National Laboratory (LANL)	
Mag Specialties Inc.	Scott Sutton
North American Diecasting Association (NADCA)	
Novelis	David Anderson John Carsley
Sandia National Laboratories	Jessica Buckner Collin Donohoue Andrew Kustas Jeff Rodelas Don Susan
The Queen City Forging Co.	Rob Mayer
Thermo-Calc Software	Paul Mason
<u>Visitors</u>	
HRL Labs Kansas City National Security Campus (KCNSC) National Institute of Standards and Technology (NIST) Tkach Consulting LLC (Forging Industry Association, FIA)	Hunter Martin Ben Sikora Adam Creuziger Suzanne Tkach
Pacific Northwest National Laboratory (PNNL)	Arun Devaraj Vineet Joshi Scott Whalen
University of California Riverside and PNNL	Suveen Mathaudhu

Meeting & General Information



- LIFE form review
 - www.iucrc.com
 - “Advanced NonFerrous Struct. Alloys (CANFSA) ”
 - Password: NoFeFall2020 (case sensitive)
 - Click on “Industry” or “Faculty” to evaluate projects
- Presentations, progress reports and executive summaries
 - www.canfsa.org
 - Under Login -> Fall 2020
 - Please email/see Alec Saville,
asaville@mymail.mines.edu
- April 2021 Meeting, April 6-8 (tentative)

Agenda Summary



All times Mountain

Entire meeting is virtual

- Tuesday, October 13
 - 8:30 am to 4:30 pm Technical Workshop
 - 12:05-1:00 pm Lunch Break
- Wednesday, October 14
 - **8:00** am to 2:45 pm Technical Workshop
 - 12:00-1:00 pm Lunch Break
 - 3:00 pm – 4:00 pm IAB Workshop (**IAB and Directors Only, Closed to Non-Members**)
 - 4:00 pm – 5:00 pm NSF Closed Session with Industry (**IAB & Center Evaluator, Closed to Non-Members**)
- Thursday, October 15
 - 8:30 – 10:45 am Technical Workshop
 - 10:45 am – 12:00 pm Report Out to CANFSA Directors (**IAB and Directors Only, Closed to Non-Members**)

Colorado School of Mines by the Numbers



- 6,522 students
 - 5,102 undergraduate and 1,420 graduate
 - 50 states, 80 countries (55.9% CO residents)
 - 30.7% female, 10.4% international
 - Largest collegiate section of SWE in the US
 - Average ACT: 31; Average SAT: 1400; Average GPA: 3.8/4.0
- >625 tenured and tenure-track, research and teaching faculty and industry professionals
 - Student/faculty ratio of 16:1
- >\$84M in research, ~35% funded by non-federal sources



National Science Foundation Industry-University Cooperative Research Center (I/UCRC)



- Established in 2011
- Multi-Site
 - Colorado School of Mines
 - Iowa State University
- Funding Sources
 - National Science Foundation
 - Phase 2
 - Industry membership dues
 - Leveraged projects
 - University overhead, facilities



Center for Advanced Non-Ferrous Structural Alloys (CANFSA) at Mines/ISU



Vision



Be the premier industry-university center for non-ferrous physical metallurgy

- Investigate industrially relevant processing-microstructure-property-performance relationships with state-of-the-art experimentation and modeling
- Connect academia, government, and industry
- Train students and the next generation of non-ferrous physical metallurgists
- Support students, faculty and curricula in physical metallurgy

What Do We Work On...?



- Al, Mg, Ti, Ni, Fe, Cu, and refractory alloys, Multi-Principal Element Alloys (MPEAs), Shape Memory Alloys (SMAs), coatings...mock high explosives
- Solidification, solid-state phase transformations and microstructural evolution, additive manufacturing, thermomechanical processing, mechanical metallurgy, dynamic materials response, severe plastic deformation...
- Novel in-situ/ex-situ characterization, non-destructive evaluation...

Membership



- Full members \$54K/year
 - Sit on Industrial Advisory Board (IAB)
 - Propose and vote on new projects
 - Entitled to a non-exclusive, royalty-free license
 - Reduced overhead
- Associate members \$18K/year
 - Small business as defined by SBIR (www.sbir.gov)
 - Sit on IAB
 - Propose and vote on new projects (1/3 votes of full members)
 - Reduced overhead

Funding Snapshot 2020



- NSF:
 - Mines: \$100K per year
 - ISU: \$100K per year
- NSF Supplemental
 - REU: \$24K (Mines)
 - INTERN: \$55K (Mines)
- Industry membership
 - ~\$545K (invoiced)
- Leveraged
 - Mines: ~\$1.2M
 - ISU: ~\$325K

Benefits of Membership



ROB MAYER
PRESIDENT, QUEEN CITY FORGING CO.



00:00

01:20



Communication and Deliverables



- Semi-annual IAB meetings (Golden, CO and/or Ames, IA)
 - Students present research results
 - Technical report
 - Executive summary
 - Technical presentation
 - New project ideas are reviewed and ranked
- Summer videoconferences
 - Students present research updates
 - Broader attendance by industrial members possible
- Project mentoring by IAB members
 - Opportunity to interact more closely with students
 - Provide industrial perspective and project guidance
- Conferences, peer-reviewed publications, and theses
- CANFSA website

Center Leadership



- Co-Directors
 - Amy Clarke, Mike Kaufman (Mines)
 - Pete Collins (ISU)



Amy



Pete

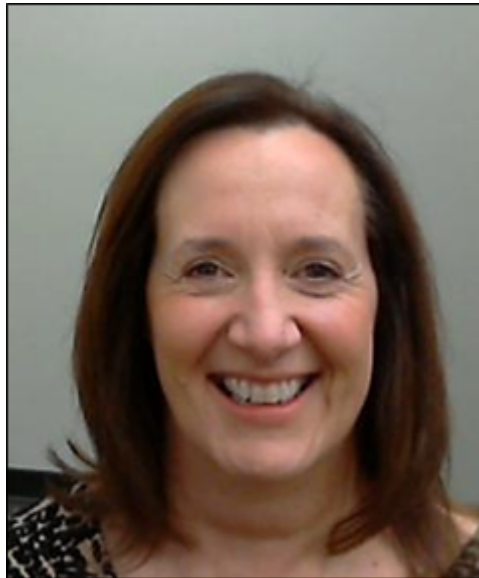


Mike

Center Staff



- Administrative
 - Debbie Haywood (Mines)



Debbie

IAB Leadership



- IAB Chair
 - Rob Mayer (Queen City Forging)
 - Paul Wilson (Boeing), incoming
 - John Carpenter (LANL), past



Paul, Boeing



Rob, QCF



John, LANL

Current Students & Postdocs



Undergraduates

- Nathan Brown (Mines)
- Lauren Drew (Mines)
- Matt Dolde (ISU)
- Darrien Hammond (Mines)
- Madison Harrington (ISU)
- Grant Johnson (ISU)
- Bobby Kaman (ISU)
- Jack Kaman (ISU)
- Dawson Tong (Mines)
- Gabriella Tuell (Mines)
- Arrianna Matthews (Mines)
- Kelsey McInturff (ISU)
- Mrinal Redij (ISU)
- Charles Smith (Mines)
- Luke Weston (ISU)

Leveraged Graduate Students

- Gus Becker (Mines)
- Scott Blazanin (ISU)
- Summer Camerlo (Mines)
- Nelson Delfino de Campos Neto (Mines)
- Benjamin Ellyson (Mines)
- Chris Jasien (Mines)
- Chloe Johnson (Mines)
- David Loyola (Mines)
- Brady McBride (Mines)
- Abigail Miklas (Mines)
- Brian Milligan (Mines)
- Katie O'Donnell (ISU)
- Alana Pauls (ISU)
- Bobby Puerling (Mines)
- Brian Rogers (Mines)
- Alec Saville (Mines)
- Jeremy Shin (Mines)
- Andrew Temple (ISU)

CANFSA Graduate Students

- Byron McArthur (Mines)
- Stuart Shirley (Mines)
- Gillian Storey (Mines)
- Noah Welch (ISU)

Postdocs

- Thomas Ales (ISU)
- Yuan Ji (ISU)
- Maria Quintana-Hernandez (ISU)
- Sri Ranga Jai Likith (Mines)

New Students (Spring and Fall 2020)



Scott Blazanin:
BS, Mines
MS, ISU, Spring 2022



Bobby Puerling:
BS, Mines
MS, Mines, Spring 2022

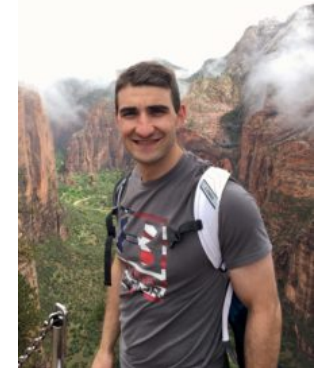


Abby Miklas:
BS, Mines
Honeywell Aerospace, Materials
Process and Engineering Group
MS, Mines, Fall 2022

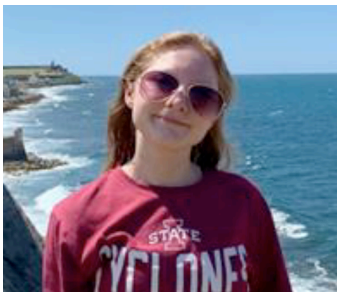


Summer Camerlo:
BS, Mines
Co-op, DePuy Synthes
MS, Mines, Fall 2022

Chris Jasien:
BS, Cal Poly Pomona
Naval Surface Warfare Center
(NSWC) Carderock Division,
Additive Manufacturing Branch,
PhD, Mines, Spring 2024



Alana Pauls:
BS/MS, ISU
PhD, ISU, Spring 2021



Noah Welch:
BS/MS, ISU
PhD, ISU, Spring 2023



Katie O'Donnell, PhD, ISU, Spring 2021
Andrew Temple, PhD, Spring 2021
Yuan Ji, PhD ISU, Postdoc
Thomas Ales, MS, ISU, Research

Recently Completed Projects



Characterization of regions in Ti-6Al-4V forgings with diminished ultrasonic inspectability	Connor Campbell, MS
Prediction and observation of transformation induced plasticity behavior in CoCrNi multi-principal element alloys with in-situ synchrotron x-ray diffraction	John Copley, MS
Solid solution strengthening mechanisms in high entropy alloys	Francisco Coury, PhD
Mechanism of swell fatigue crack initiation in Ti-7Al under biaxial tension-tension loads	Garrison Hommer, PhD
Development of novel high temperature aluminum alloys	Joe Jankowski, PhD
Effects of thermal processing variations on microstructure and high cycle fatigue of β-STOA Ti-6Al-4V	Bryon McArthur, MS
Characterization of microstructures and mechanical properties in linear friction welded and electron beam additively manufactured Ti-6Al-4V	Michael Mendoza, PhD
Development of nickel-titanium-hafnium alloys for impact resistant tribology performances	Sean Mills, PhD

Current Projects



Algorithmic analyses of X-radiography and computed tomography for multiscale structural investigations of metals	Gus Becker, PhD
Failure analysis of fracture toughness tested AM Ti-64 weldments	Scott Blazanin, ISU
Advanced characterization of particulate materials simulating high explosives	Summer Camerlo
Advanced engineered coatings with extended die life for tooling	Nelson Delfino de Campos Neto, PhD
In-situ studies of strain rate effects on phase transformations and microstructural evolution in β-titanium alloys	Ben Ellyson, PhD
Microstructure and processing links in β-titanium during additive manufacturing	Chris Jasien, PhD
Mechanisms of grain refinement in laser powder bed fusion of in-situ metal matrix composite 6061 aluminum alloys	Chloe Johnson, PhD
Development and characterization of thick electron beam welded commercial Al-Cu alloy	David Loyola, MS
Phase and texture evolution preceding abnormal grain growth in Ni-based aerospace alloys	Byron McArthur, PhD
Accumulative roll bonding of Al sheets toward low temperature superplasticity	Brady McBride, PhD

Current Projects



Processing and properties of multi-principal element alloys	Abigail Miklas, MS
Identification of deformation mechanisms of thermally stable cast Al-Cu alloys via neutron diffraction	Brian Milligan, PhD
Rationalization of liquid/solid interface instabilities during thermal-mechanical transients of metal additive manufacturing	Katie O'Donnell, PhD
Defect assessment in additively manufactured materials	Alana Pauls, MS
Thermodynamics of refractory alloys	Bobby Puerling, MS
In-situ characterization of microstructural evolution during simulated additive manufacturing in model alloys	Brian Rodgers, PhD
Microstructural evolution in Ti alloys under additive manufacturing conditions	Alec Saville, PhD
Characterizing additively manufactured Inconel 718/738	Jeremy Shin, PhD
Evaluation of processing path effects on microstructure and properties of powder Al-TM alloy	Stuart Shirley, MS
Solute and precipitate effects on magnesium recrystallization	Gillian Storey, MS
Predicting mechanical behavior in AM titanium alloys	Andrew Temple, PhD
Oxidation in RCCA materials	Noah Welch, PhD

2020 IAB Project List

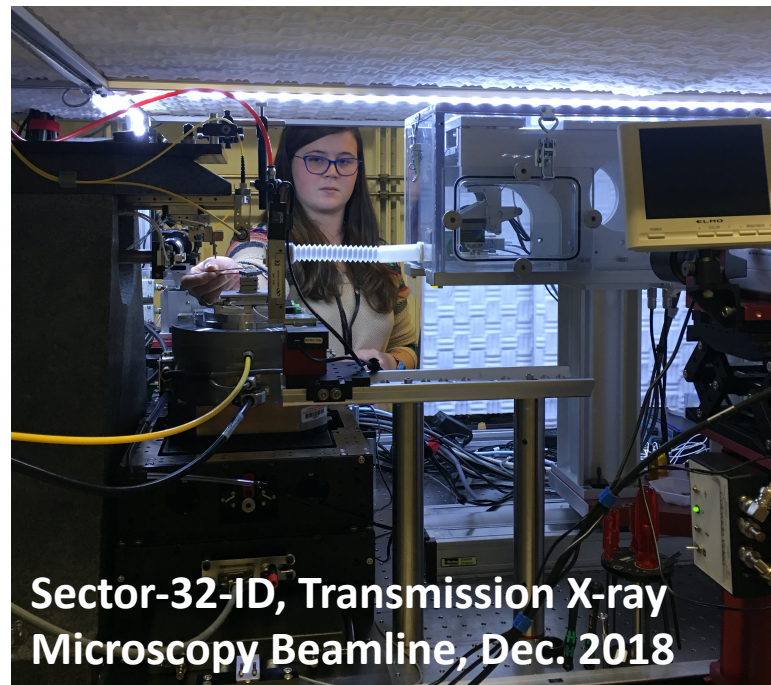


# Companies	# Votes	2020 IAB Project List	Proposer
6	39	Influence of microstructure on the oxidation behaviors of refractory complex concentrated alloys (RCCAs) (Noah Welch, PhD, ISU)	AFRL
3	35	Understanding influence of heat-treatment on serrated yielding in a Ni superalloy (Nathan Brown, UG, Mines)	Honeywell
6	34	Shock compression and dynamic deformation processes influencing cold spray bonding mechanisms, microstructure, and defect evolution in repair of dissimilar legacy alloys (Needs follow-up)	Boeing, AFRL
5	28	Development of substructure during additive manufacturing of titanium alloys (Alec Saville, PhD, Mines and Chris Jasien, PhD, Mines)	AFRL
4	26	Control of complex cracking behavior in high-strength aluminum alloys (Scott Blazanin, MS, ISU)	AFRL
6	26	Microstructural evaluation of additively manufacturing AlSi10Mg as a function of thermal treatment	Boeing
4	25	Origins of time dependent springback in aluminum alloys (Dawson Tong, UG, Mines)	Novelis
4	25	Microstructural engineering of high strength aluminum alloys for hydrogen infrastructure	Novelis
1	25	Ti-6Al-4V implant coatings/surface treatments for improved wear performance against UHMWPE (New PhD, Mines, Spring 2021)	DePuy Synthes
3	17	Role of grain boundary disconnection dynamics on microstructure evolution during superplastic forming	AFRL

Selected Highlights & Tech Transfer



- Chloe Johnson was awarded NSF INTERN supplemental funding to work at Elementum 3D (Spring 2020, Summer 2020)
- CANFSA students participated in 2020 summer videoconference series (June/July 2020)
- John Copley successfully defended his MS thesis entitled “Prediction and observation of transformation induced plasticity behavior in CoCrNi multi-principal element alloys with in-situ synchrotron x-ray diffraction” (July 2020)
- Amy Clarke gave virtual seminars during the “Probing mesoscale materials dynamics with x-rays, neutrons, and protons” and “In-situ sensing and process monitoring for NNSA relevant materials and processes” at LANL (August 2020)



**Sector-32-ID, Transmission X-ray
Microscopy Beamline, Dec. 2018**

Example New(er) Capabilities @ Mines



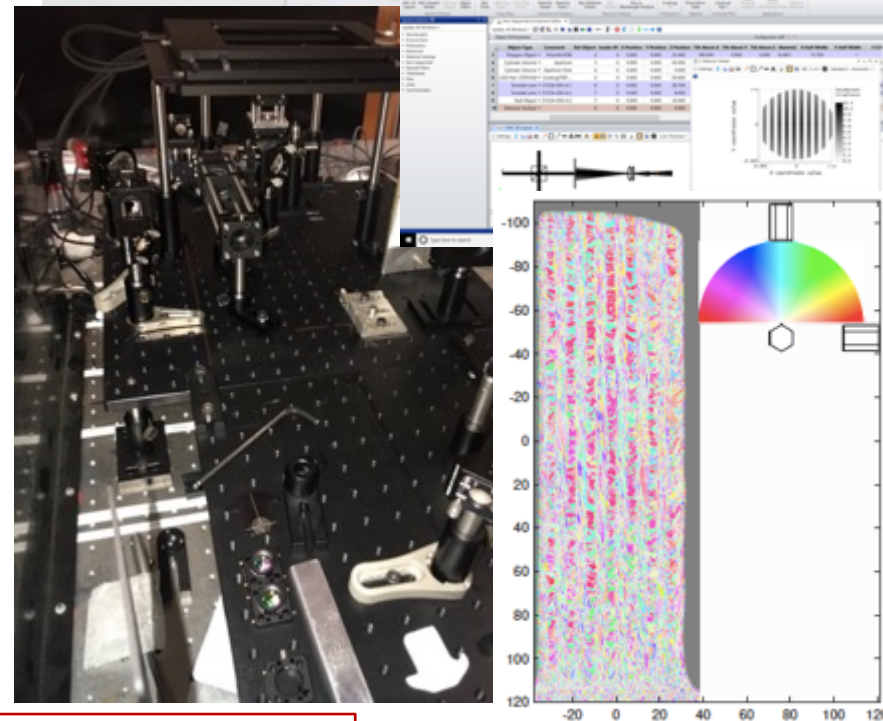
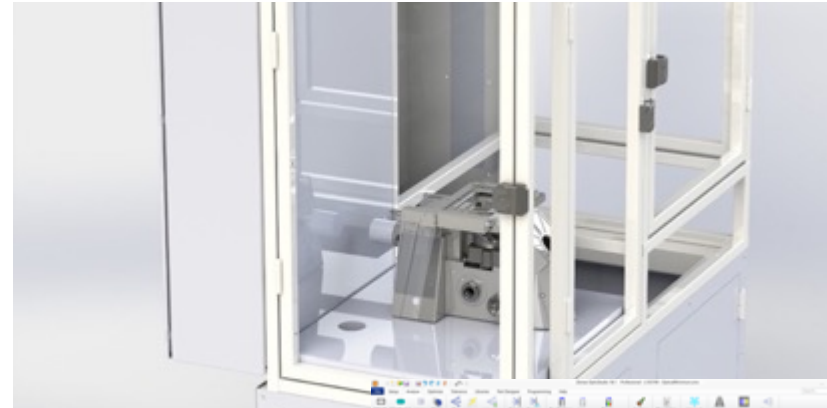
- High-energy Micro-focus X-ray Imaging Cabinet
- Zeiss Versa 520 X-ray CT Microscope
- Panalytical Empyrean X-ray Diffractometer
- Interlaken SP400 Servopress
- ArcCast Arc 200 Cold Crucible (alloying, casting, atomization)



New Capabilities: Robo.Met with SRAS @ ISU



- Developing the worlds first 3D SRAS system
- SRAS (spatially resolved acoustic spectroscopy) uses a laser to generate an elastic surface acoustic wave, which results in displacements measured by another laser
- There is no commercial supplier of such a system, and so we are expending considerable effort to design, build, and deploy this system
- Areas of orientation mapping exceed 1500 square millimeters. Volumes of reconstruction will exceed 20,000 sq. millimeters



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industry-nominated stories that will **inspire and attract companies and partners to form new collaborative research centers or join existing centers** with industry, universities, and other government agencies including national labs.





NSF-FUNDED RESEARCH

Steering a virtual hurricane to understand impacts

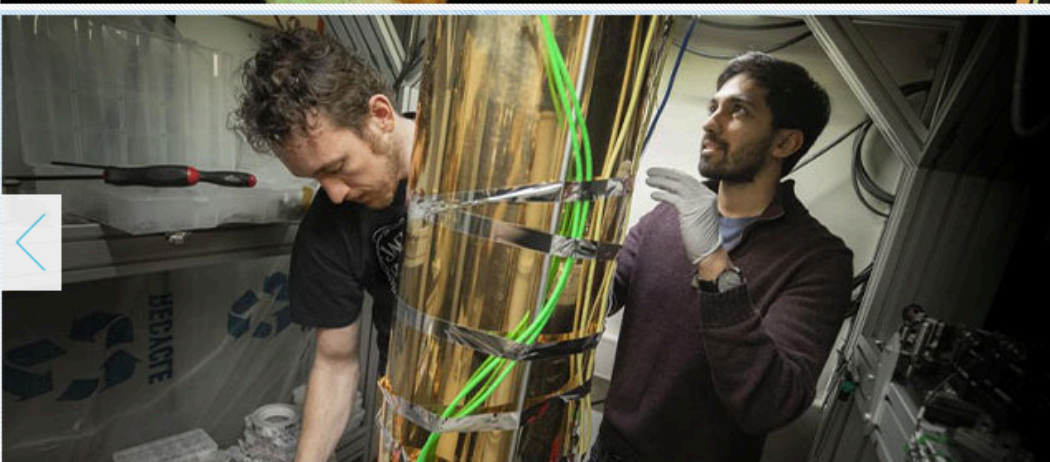
FULL STORY



NSF-FUNDED RESEARCH

Plants, animals respond similarly in changing climates

FULL STORY



NSF-FUNDED RESEARCH

Toward an unhackable quantum internet

FULL STORY



Has CANFSA passed the baton?

Does your organization have a noteworthy Center outcome that has resulted in:

- **New processes or process improvements**
- **New or improved products or services, or spin-off products and services**
- **Productivity improvements (increased yield)**
- **Technology transfer and commercialization successes**
- **New competitive advantage; increased market share or penetration expansion**
- **Information/estimates on economic benefits such as cost savings, increased profits and/or job growth for the sponsor, the industrial sector, and/or the nation's economy.**





Questions/comments?

Amy Clarke

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Phone: 303-273-3893