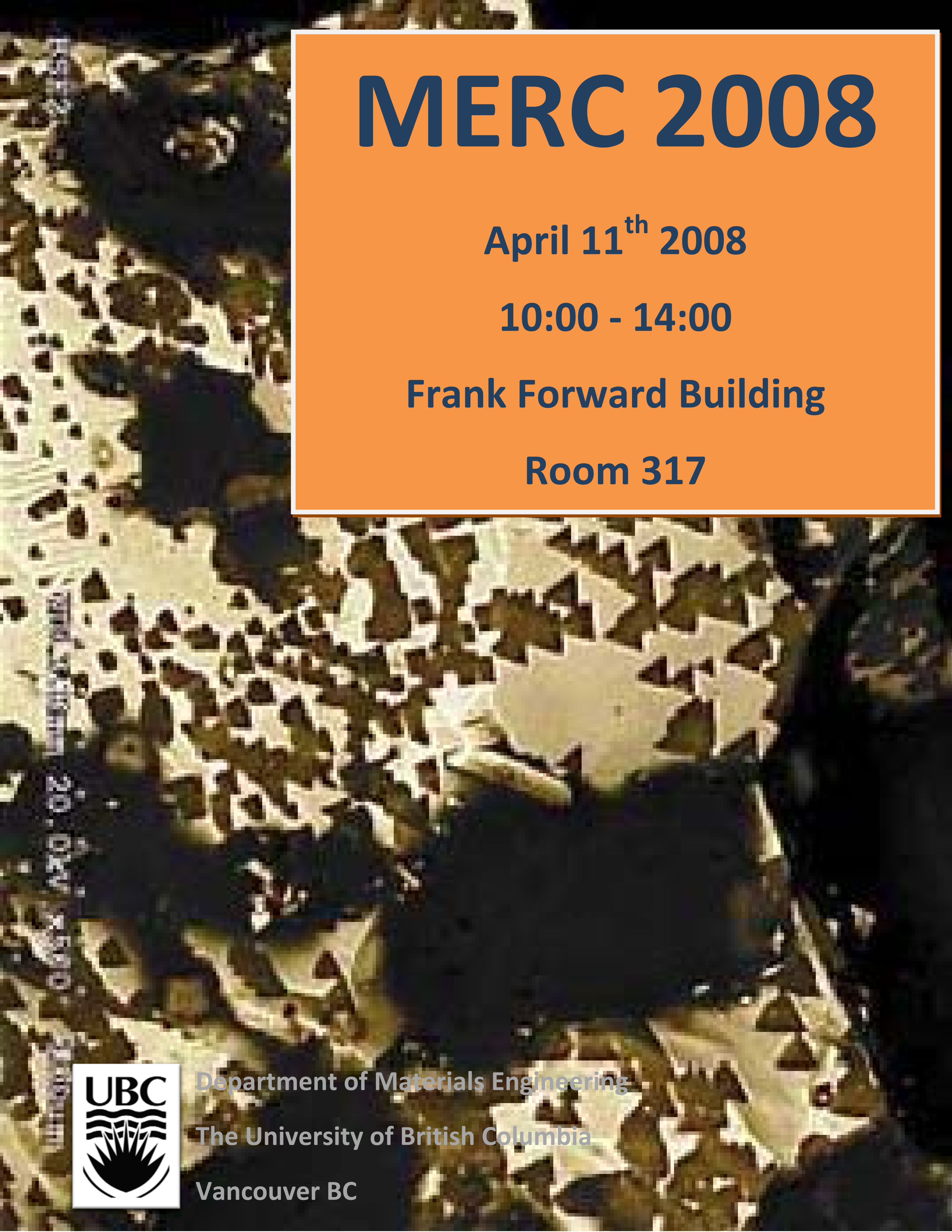


MERC 2008

April 11th 2008

10:00 - 14:00

Frank Forward Building

Room 317

UBC

Department of Materials Engineering

The University of British Columbia

Vancouver BC

Materials Engineering Research Colloquium Schedule

Friday April 11th, 2008

Presenter	Time	Title
S. Lu	10:00	Titanium implant modified with antimicrobial peptide: Preliminary experiments
T. Meng	10:30	Modeling Marangoni Effects in Electron Beam Remelting of Ti-6Al-4V
J. Jain	11:00	Study of deformation modes in Mg-8Al-0.5Zn magnesium alloy
B. Rivera	11:30	Electrochemistry and Transpassive Leaching of Single Sulfide Particles
LUNCH	**12:00**	
R. Yao	13:00	Thermal Barrier Coating Assisted by Chemically Bonded Composite Sol-Gel with Strain Compliant Microstructure
F. Xie	13:30	Recovery of Copper and Cyanide from Gold Mill Effluents by Solvent Extraction
D. Marechal	14:00	Influence of grain size on the TRIP effect in 301LN austenitic stainless steels

Titanium implant modified with antimicrobial peptide: Preliminary experiments

Shanshan Lu and Rizhi Wang

Research Summary:

In orthopedic surgeries, implants-associated infections are always among the most serious complications which may subsequently lead to device failures. Traditional antibiotic treatments have been facing a dramatic rise of microbial resistance, thus leading to the insight of novel anti-infective solutions, one of which is lying on a naturally-occurred antimicrobial peptide family. Because pathogens are less likely to develop resistance to them, these peptides are considered as a promising alternative for future clinical treatment.

In this research, we are currently working in collaboration with the Microbiology Lab of UBC, where the researchers are focusing on developing short yet effective microbe-killing peptides. The objective is to immobilize the unique peptide onto the surface of titanium and thus to induce bactericidal activity and resistance to infections after the device being implanted.

Titanium surface was first functionalized by chemical treatments, and a specific short linker was then attached to the surface functional groups. As a preliminary test, one single amino acid, cysteine, was coupled to the linker through covalent bond. Subsequent fluorescent test confirmed the existence of cysteine on the titanium surface, which indicates the possibility of further immobilization of the poly-amino-acid peptide.

To physically determine the successful coupling of the peptide, a fluorescent method was employed which ensures detecting sensitivity in this case of minimum amount of peptide present. After confirmation of the chemical attachment, bactericidal experiment is proposed to demonstrate the surface's capability of killing common infection-related pathogens. The effect of modifying the linker length on the bactericidal ability will also be studied in future.

Modeling Marangoni Effects in Electron Beam Remelting of Ti-6Al-4V

Tao Meng, Daan Maijer, Steven L. Cockcroft

Research Summary:

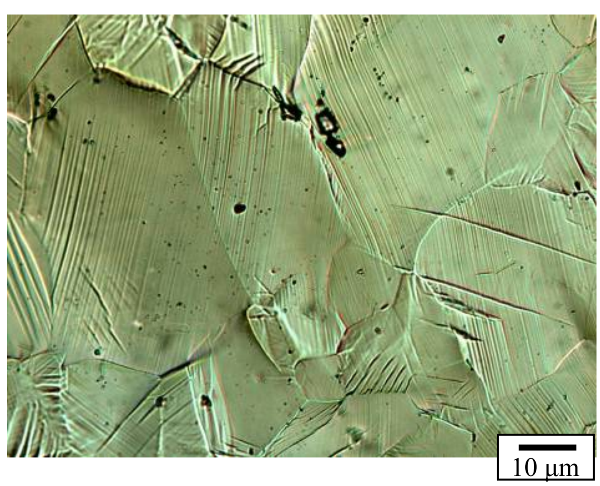
Electron Beam Cold Hearth Remelting (EBCHR) and its associated casting process has become a cost effective means to recycle titanium scrap. Large thermal gradients develop in the regions where the electron beams dwell. This leads to variations in the surface tension energy close to beam inducing thermocapillary (Marangoni) flow. A mathematical model of the fluid flow and heat transfer in a Ti6Al4V button sample during solidification has been developed to examine the relative contributions of Marangoni and buoyancy effects. Additionally, this model has been used to study the impact of time-based averaging of the boundary condition describing the beam pattern.

Study of deformation modes in Mg-8Al-0.5Zn magnesium alloy

Jayant Jain, Warren J. Poole and Chad W. Sinclair
Brimacombe Building, Rm 349
Department of Materials Engineering, The University of British Columbia

Research Summary:

With increasing demand for lightweight structural materials in, for example, the automotive and aerospace industries, wrought magnesium alloys have grown in importance. However, because of limited room temperature ductility and anisotropic plastic behaviour, the current applications of wrought magnesium alloys are limited. In general, deformation behaviour of magnesium alloys is complex. The activation of the various deformation modes (basal, prism and pyramidal slip and $\{10\bar{1}2\}$-tension or $\{10\bar{1}1\}$-compression twins) depends on temperature, alloy composition, grain size, crystallographic texture and second phase precipitates. Further, there is a lack of systematic studies where these factors have been examined over a wide range of conditions. The results presented in this talk form a subset of a larger experimental matrix where the grain size, initial crystallographic texture and precipitate state are being systematically examined for the commercial alloy AZ80 (Mg-8wt.%Al-0.5wt.% Zn). In this work, the initial microstructure was an as-cast structure which had a grain size of approximately 32 µm and a near random crystallographic texture. The material was tested in the supersaturated solid solution condition and in the state where there was a high volume percentage (10-11%) of β ($Mg_{17}Al_{12}$) phase in the matrix in uniaxial compression at 77K and 293K. We will report on the macroscopic stress-strain response and the observations on microscopic deformation mechanisms. Slip markings on the surface of deformed specimens were observed using an optical microscope with Nomarski interference contrast. The operative slip modes were determined on the basis of slip trace analysis. The sequential electron backscattered diffraction (EBSD) patterns were used to provide the information on deformation twinning. Results of slip trace analysis suggest the presence of non-basal (prism and pyramidal) slip (both <a> and <c+a> type) in solution-treated and aged conditions at both 77K and 293K.



Slip markings in AZ80 alloy deformed to 5 % strain at 77K

Electrochemistry and Transpassive Leaching of Single Sulfide Particles.

Berny Rivera-Vasquez, David G. Dixon
Frank Forward Building, Room 417
Department of Metals and Materials Engineering, University of British Columbia

Chalcopyrite is of primary interest in the metals industry because it contains around 70% of the total reserves of copper in the world. It is extremely difficult to leach because it self-passivates in different leaching media, stopping the chemical leaching reactions. Overcoming chalcopyrite passivation is the ultimate objective of many current research projects, both in academy and industry. Electrochemical techniques have been used to study the behavior of sulfide minerals using millimeter-size massive samples or lately carbon in paste electrodes (CPE). Both methods present controversy about reproducibility. This problem has been assumed to be due to impurities on samples, polarization on surface, or interference due to binders for the case of CPE.

As an aim to unravel this problem, the objective of this work was to develop a technique that will allow us to execute electrochemical studies to micron-size particles. This will help us to understand how a single particle of a given concentrate will behave inside of a reactor during the leaching process. A new electrochemical mini-cell instrument has been successfully implemented and tested. This new tool consists of a temperature-controlled electrochemical cell that allows the study of individual particles. Different electrochemical analyses such as conductivity, cyclic voltammetry, linear polarization, and leaching of particles have been performed. Also, in a near future, in-situ and ex-situ Raman spectroscopy surface characterization will be studied.

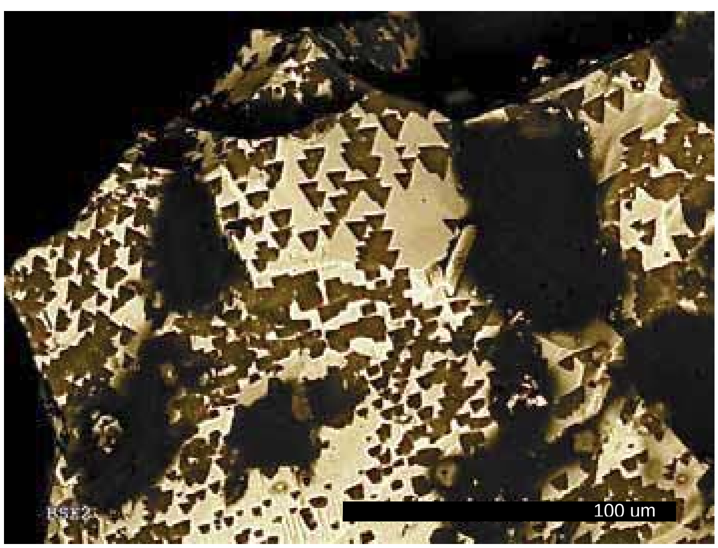


Figure 1: SEM Micrograph of a single chalcopyrite particle (1M H2SO4 + 1M NaCl) at 30 seconds of transpassive leaching.

Thermal Barrier Coating Assisted by Chemically Bonded Composite Sol-Gel with Strain Compliant Microstructure

Ray Yao, Tom Troczynski
Room 106a, Frank Forward
Department of Materials Engineering, University of British Columbia

Research Summary:

Thermal Barrier Coating system (TBC) used in high temperature operations are typically deposited by Electron-Beam Physical-Vapor-Deposition (EB-PVD) or Air Plasma Spray (APS). The microstructures, and hence advantages, resulting from each deposition technique are distinctive. EB-PVD produces a microstructure which improves the compliance of thermal strain while APS produces a microstructure with lower thermal conductivity which is desirable as a thermal insulative application. The UBC Ceramics group (UBCeram) takes advantage of the Chemically-Bonded Composite Sol-Gel (CB-CSG) technology with its ability to incorporate filler particles in the sol-gel matrix. The spraying process used in CB-CSG exerts a certain degree of control over microstructure, porosity, and thickness through adjusting the spraying parameters such as air pressure, spraying angle, substrate temperature, and distance between substrate and spray gun. The result is a coating that allows varying ratio between alumina and YSZ as well as vertical texture through a progressive build-up spraying technique. UBCeram aims to combine the vertically textured softer CB-CSG with the thermal insulative APS coating to achieve a TBC that is both thermal strain compliant as well as highly resistive to heat transfer.

Recovery of Copper and Cyanide from Gold Mill Effluents by Solvent Extraction

Feng Xie, David Dreisinger
Department of Materials Engineering, University of British Columbia
309-6350 Stores Road, Vancouver, BC, Canada V6T 1Z4

Research Summary:

Recovery of valuable copper and cyanide from gold mill effluents is a matter of interest from both an environmental and an economic point of view. Current recovery methods are either costly or still underdeveloped. The use of a solvent mixture of a quaternary amine and nonylphenol to extract copper and cyanide from waste cyanide solution was studied in this work. Effective copper extraction and stripping can be achieved by adjusting the equilibrium pH in aqueous phase. Copper extraction is favorable at low pH while a high cyanide to copper ratio tends to suppress copper loading. The extractant also strongly extracted zinc and nickel from cyanide solution, but the extraction of iron is negligible. Part of the cyanide is extracted by the extractant occurring as metal cyanide complexes. The presence of thiocyanate ion significantly depressed copper extraction, but thiosulfate ion produced little impact on copper extraction.

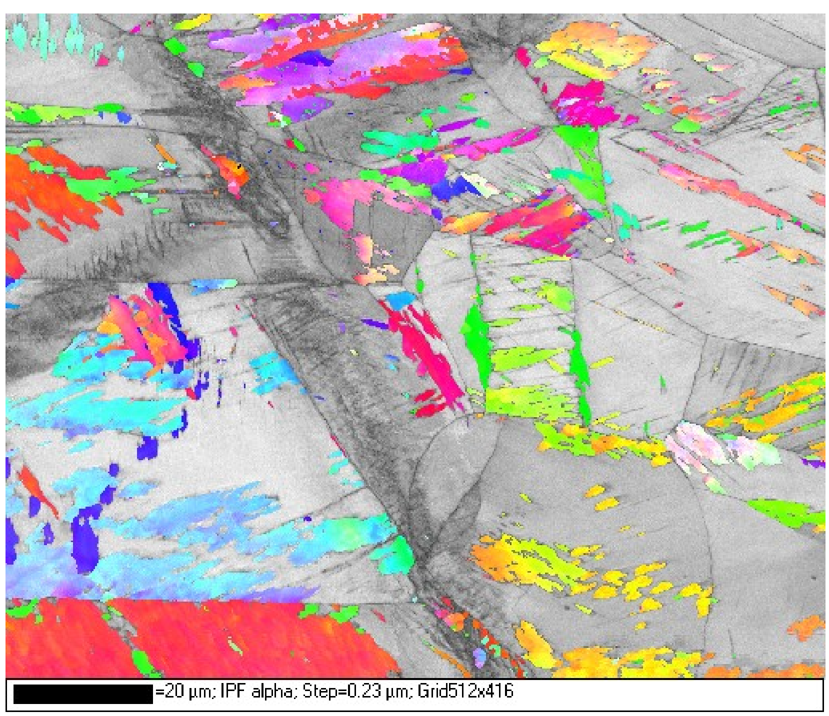
Influence of grain size on the TRIP effect in 301LN austenitic stainless steels

David Marechal, C.W. Sinclair
AMPEL 260
Department of Materials Engineering, The University of British Columbia

Research Summary:

Austenitic stainless steels display unusual hardening behaviour attributed to the deformation–induced transformation of austenite into martensite. This strain-induced martensitic transformation leads to the formation of a “dynamic dual-phase material”, usually referred to as TRIP effect – an acronym for transformation-induced plasticity. Although austenitic stainless steels provide favourable conditions for grain size refinement, little is known about the influence of grain size on the phase transformation and how it affects the mechanical properties.

Martensite measurements were carried in specimens of 301LN steel displaying different grain sizes and deformed in tension. Back-scattered electron microscopy was used to assess the morphology and the favourable sites for the nucleation of martensite. It appears that, at low strains, the initial grain size of the austenite influences the nucleation sites and the morphology of the martensite. At higher strains, the effect of grain size is hidden by the successive variants of martensite which have been formed, therefore bringing the stress-strain curve at similar levels. A simple law of mixture has been applied to capture the stress-strain relation in 301LN.



EBSD orientation map showing austenitic grains (in grey) filled with martensite variants (coloured).