

# Program of the 182<sup>nd</sup> ISIJ Meeting (September 2-4, 2021)

## Discussion Sessions

### Processing for Quality Products

| Lecture No.<br>Discussion Session                    | Title                                                                                                            | Speaker       | Page      |
|------------------------------------------------------|------------------------------------------------------------------------------------------------------------------|---------------|-----------|
| <b>Advances in lubrication technology of rolling</b> |                                                                                                                  |               |           |
| 13:05-13:30                                          |                                                                                                                  |               |           |
| D1                                                   | In situ observation of lubricant on rolling interface                                                            | H. Utsunomiya | • • • 278 |
| 13:30-13:55                                          |                                                                                                                  |               |           |
| D2                                                   | (Invited Lecture) Effect of additives Mixed in lubricating oil on oil film formation and coefficient of friction | T. Hirayama   | • • • 280 |
| 13:55-14:20                                          |                                                                                                                  |               |           |
| D3                                                   | In situ observation of extreme pressure agent in EHL oil films by a micro infrared spectroscopy                  | A. Miura      | • • • 282 |
| 14:20-14:45                                          |                                                                                                                  |               |           |
| D4                                                   | Estimation of surface topology based on rolling pressure distribution                                            | Y. Okada      | • • • 283 |
| 15:00-15:25                                          |                                                                                                                  |               |           |
| D5                                                   | Consideration of emulsion lubrication described by $\mu$ -EHL and 3D-stribeck-curve                              | T. Fukuda     | • • • 285 |
| 15:25-15:50                                          |                                                                                                                  |               |           |
| D6                                                   | Fundamental study of lubrication characteristics of high strength steel in cold rolling                          | M. Shimura    | • • • 286 |
| 15:50-16:15                                          |                                                                                                                  |               |           |
| D7                                                   | Development of cold rolling oil for tinplate with high ESI                                                       | T. Ishii      | • • • 290 |
| 16:15-16:40                                          |                                                                                                                  |               |           |
| D8                                                   | Effect of applying lubricant in hot rolling                                                                      | S. Watanabe   | • • • 294 |

### Microstructure and Properties of Materials

#### Heterogeneous deformation and fracture in high strength steels

|             |                                                                                                                                                                           |               |           |
|-------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|-----------|
| 9:00-9:30   |                                                                                                                                                                           |               |           |
| D9          | Effect of alloying elements on the formation of white structure under rolling contact fatigue                                                                             | M. Natori     | • • • 296 |
| 9:30-10:00  |                                                                                                                                                                           |               |           |
| D10         | Visualization of strain distribution during tensile deformation in a martensitic steel by using digital image correlation method on replica films                         | N. Koga       | • • • 299 |
| 10:00-10:30 |                                                                                                                                                                           |               |           |
| D11         | Evaluation of inhomogeneous deformation behavior by nano-scale DIC analysis in medium-Mn steel treated with interrupted quenching and intercritical annealing             | T. Masumura   | • • • 301 |
| 10:45-11:15 |                                                                                                                                                                           |               |           |
| D12         | Deformation behavior of medium manganese steels at cryogenic temperature monitored by neutron diffraction                                                                 | T. Yamashita  | • • • 302 |
| 11:15-11:45 |                                                                                                                                                                           |               |           |
| D13         | Formation of deformation-induced transformation texture in SUS 304 stainless steel                                                                                        | Y. Onuki      | • • • 306 |
| 13:00-13:30 |                                                                                                                                                                           |               |           |
| D14         | Analysis of the interaction between dislocations and twin boundaries in FCC iron using the molecular dynamics                                                             | K. Kawatsu    | • • • 308 |
| 13:30-14:00 |                                                                                                                                                                           |               |           |
| D15         | Molecular dynamics analysis of nucleation mechanism of martensite transformation in polycrystalline materials                                                             | T. Shimokawa  | • • • 309 |
| 14:00-14:30 |                                                                                                                                                                           |               |           |
| D16         | High-temperature digital image correlation analysis of plastic deformation with Portevin-LeChatelier effect in austenitic stainless steel                                 | S. Lee        | • • • 310 |
| 14:45-15:15 |                                                                                                                                                                           |               |           |
| D17         | (ISIJ Research Promotion Grant) Variant analysis on deformation-induced $\gamma \rightarrow \epsilon \rightarrow \alpha'$ martensitic transformation in Fe-5Mn-0.1C steel | T. Sawaguchi  | • • • 312 |
| 15:15-15:45 |                                                                                                                                                                           |               |           |
| D18         | Strength and deformation of ferritic steel with mixed dispersion of hard and soft phases                                                                                  | T. Tsuchiyama | • • • 314 |

# Program of the 182<sup>nd</sup> ISIJ Meeting (September 2-4, 2021)

## Process Evaluation and Material Characterization

### On-line analysis for iron and steel making processes

13:35-14:05

D19 Rapid determination of minor elements in low alloy steel by laser induced breakdown spectroscopy and deep neural network

S. Kashiwakura · · · 317

14:05-14:35

D20 A review on on-line measuring technique in steelmaking processes

Y. Uchida · · · 319

14:35-15:05

D21 Application of laser induced breakdown spectroscopy to iron and steel making processes

Y. Deguchi · · · 320

# Program of the 182<sup>nd</sup> ISIJ Meeting (September 2-4, 2021)

## High Temperature Processes

| Lecture No.                                    | Title                                                                                                                                                                                             | Speaker      | Page      |
|------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|-----------|
| Plenary Session                                |                                                                                                                                                                                                   |              |           |
| <b>Solidification and structure control</b>    |                                                                                                                                                                                                   |              |           |
| 1                                              | Measurement of change in the lattice constant of Fe-C alloy before and after $\delta$ - $\gamma$ transformation                                                                                   | Y. Nanri     | • • • 322 |
| 2                                              | Effects of Ti on coarsening of gamma grains produced by a massive-like transformation in carbon steels                                                                                            | S. Tsuji     | • • • 323 |
| 3                                              | Effect of residual $\delta$ phase on $\gamma$ phase coarsening after a massive-like $\delta/\gamma$ transformation in Fe-18Cr-11Ni alloy                                                          | T. Narumi    | • • • 324 |
| 4                                              | Quantitative evaluation of dendrites in 304 stainless steel by using time-resolved tomography                                                                                                     | M. Nonomura  | • • • 325 |
| 5                                              | Time-resolved and in-situ observation of $\alpha$ - $\gamma$ transformation in TiAl alloys                                                                                                        | T. Nishimura | • • • 326 |
| <b>Continuous casting and solidification</b>   |                                                                                                                                                                                                   |              |           |
| 6                                              | Compositional and morphological changes of Mn-Si-Al deoxidation products during solidification of steel                                                                                           | J. Gamutan   | • • • 327 |
| 7                                              | Influential factors on solidification cracking susceptibility of stainless steels with F-mode solidification                                                                                      | K. Kadoi     | • • • 328 |
| 8                                              | Effect of Ti addition and thermal history on hot ductility of Nb containing steel                                                                                                                 | S. Takaya    | • • • 329 |
| 9                                              | Efforts to improve durability by controlling thermal expansion of tundish safety lining                                                                                                           | Y. Tsutsui   | • • • 330 |
| <b>Reduction and carburization</b>             |                                                                                                                                                                                                   |              |           |
| 10                                             | Effect of reduction characteristic of fine iron ore by pulverized coal on atmospheric gas                                                                                                         | K. Yamamoto  | • • • 331 |
| 11                                             | Formation mechanism of fine fibrous metallic iron by hydrogen reduction of iron oxide                                                                                                             | N. Toyoshima | • • • 332 |
| 12                                             | The analysis of hematite( $\text{Fe}_2\text{O}_3$ )-reduction with nitride                                                                                                                        | N. Ishikawa  | • • • 333 |
| 13                                             | Investigation of pre-reduced iron ore production for blast furnace development of adiabatic counter current moving bed for shaft furnace reaction simulator -2                                    | M. Mizutani  | • • • 334 |
| 14                                             | Carburization and melting behavior of reduced iron in carbon-iron ore composite using un-carbonated biomass                                                                                       | R. Higashi   | • • • 335 |
| <b>Lower part of blast furnaces</b>            |                                                                                                                                                                                                   |              |           |
| 15                                             | DEM-CFD simulation on clogging behavior of narrow path in blast furnace                                                                                                                           | D. Tsukada   | • • • 336 |
| 16                                             | Effect of reduction degree of sinter iron ore on slag penetration behavior against graphite balls packed layer                                                                                    | R. Tani      | • • • 337 |
| 17                                             | Analysis of deformation behavior of packed bed in blast furnace cohesive zone by the Bingham fluid model                                                                                          | M. Tanaka    | • • • 338 |
| 18                                             | (ISIJ Research Promotion Grant) Fast dynamic model of sintered ore softening deformation                                                                                                          | S. Natsui    | • • • 339 |
| <b>Iron ore and sinter</b>                     |                                                                                                                                                                                                   |              |           |
| 19                                             | Effects of some factors on gangue removal from iron ore by alkali hydrothermal treatment                                                                                                          | Y. Mochizuki | • • • 340 |
| 20                                             | Effect of multiple and slit burner on decreasing combustion energy in view of combustion efficiency development of REMO-tec (RE-ignition method for optimization of total energy consumption) - 4 | M. Matsumura | • • • 341 |
| 21                                             | Phase relation between quaternary calcium ferrite and liquid on the $\text{CaO-SiO}_2\text{-Fe}_2\text{O}_3\text{-5mass\% Al}_2\text{O}_3$ system at 1240°C in air                                | Y. Uchisawa  | • • • 342 |
| <b>Young engineer session of ironmaking</b>    |                                                                                                                                                                                                   |              |           |
| 22                                             | Relation between high temperature reducibility and pore factors                                                                                                                                   | S. Yamada    | • • • 343 |
| 23                                             | Development of steam heating granulation technology for increasing sinter productivity                                                                                                            | S. Fujiwara  | • • • 344 |
| 24                                             | Effect of applying “Lump Ore MEBIOS” on sinter productivity in Oita No.1 sintering machine                                                                                                        | T. Sugiura   | • • • 345 |
| 25                                             | Improvement of coke layer shape by increasing rotating speed of bell-less chute                                                                                                                   | Y. Ogasawara | • • • 346 |
| <b>Young engineer session of coke-making 1</b> |                                                                                                                                                                                                   |              |           |
| 26                                             | Investigation of melting behavior of low-fluidity coal by synchrotron X-ray imaging                                                                                                               | S. Arakawa   | • • • 347 |
| 27                                             | Development of a new evaluation apparatus for coking pressure                                                                                                                                     | K. Ishimoto  | • • • 348 |
| 28                                             | Development of ceramic welding lance in combustion chamber                                                                                                                                        | D. Watanabe  | • • • 349 |
| <b>Young engineer session of coke-making 2</b> |                                                                                                                                                                                                   |              |           |
| 29                                             | Improving management systems of coal blending for reducing quality variation of coke                                                                                                              | R. Kubo      | • • • 350 |
| 30                                             | Development of diagnostic technology of coke oven profile and application for repairing                                                                                                           | Y. Arimura   | • • • 351 |
| 31                                             | Wear resistance of materials of frictional parts in an equipment for a coal reforming process                                                                                                     | Y. Shimobe   | • • • 352 |

# Program of the 182<sup>nd</sup> ISIJ Meeting (September 2-4, 2021)

## Coal and coke

|    |                                                                                                                      |            |       |     |
|----|----------------------------------------------------------------------------------------------------------------------|------------|-------|-----|
| 32 | Improvement of combustion function by adjusting combustion gas supply time                                           | T. Tani    | • • • | 353 |
| 33 | Development of coal shrinkage measuring equipment with simulating pressuring conditions during carbonization process | S. Matsuo  | • • • | 354 |
| 34 | Effect of char structure and gasification agent on gasification behavior of pulverized coal char                     | T. Negishi | • • • | 355 |

## Frontier of high temperature physical chemistry in oxide/metal interface 1

|    |                                                                                                                                                                     |             |       |     |
|----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|-------|-----|
| 35 | Measurement of time-resolved synchrotron X-ray total scattering pattern for a calcium ferrite melt                                                                  | S. Sukenaga | • • • | 356 |
| 36 | Measurement of diffusion coefficient of O <sup>2-</sup> ion in molten SiO <sub>2</sub> -Na <sub>2</sub> O-NaF system                                                | O. Takeda   | • • • | 357 |
| 37 | Evaluation of thermal resistance of Si-rich layer in oxide scale formed on heavy steel plate                                                                        | R. Endo     | • • • | 358 |
| 38 | Mass transport of the Zr-O-(Fe, Cr, Ni) system during the SUS316-Zircaloy4 reaction at high temperatures under the severe accident condition of light water reactor | A. Itoh     | • • • | 359 |

## Frontier of high temperature physical chemistry in oxide/metal interface 2

|    |                                                                                                                                       |             |       |     |
|----|---------------------------------------------------------------------------------------------------------------------------------------|-------------|-------|-----|
| 39 | Wettability of Al <sub>2</sub> O <sub>3</sub> , MgO, or MgAl <sub>2</sub> O <sub>4</sub> substrate against molten Fe-18%Cr-9%Ni alloy | N. Saito    | • • • | 360 |
| 40 | Viscosity evaluation of Fe <sub>x</sub> O-CaO-SiO <sub>2</sub> foaming slag generated by interfacial reaction                         | N. Saito    | • • • | 361 |
| 41 | In-situ observation method of foaming behavior of molten slag                                                                         | M. Nakamoto | • • • | 362 |

## Introduction of research topics in novel processing forum

|    |                                                                                  |             |       |     |
|----|----------------------------------------------------------------------------------|-------------|-------|-----|
| 42 | Hydrogen production by reaction between liquid zinc and water vapor              | C. Kasahara | • • • | 363 |
| 43 | Recovery Nd from Nd-Fe-B magnets using Bi and Al melts                           | S. Niwa     | • • • | 364 |
| 44 | Effect of operating conditions on reaction enhancement by ultrasonic irradiation | T. Inagaki  | • • • | 365 |

## Electromagnetic processing of materials

|    |                                                                                                                                                                 |              |       |     |
|----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|-------|-----|
| 45 | Some specific phenomena observed in microwave processing for metal production and recycling                                                                     | N. Yoshikawa | • • • | 366 |
| 46 | Imposition of electromagnetic field on an alloy during solidification for reduction of shrinkage cavity                                                         | Y. Nishi     | • • • | 367 |
| 47 | Velocity suppression effect comparison between uniform and gradient magnetic fields on flowing tin in packed bed composed of high electrical conductivity solid | G. Kusunoki  | • • • | 368 |

## Sustainable Systems

Lecture No.

Plenary Session

Title

Speaker

Page

### Effective application of the steelmaking slag and dust 1

|    |                                                                                                             |         |       |     |
|----|-------------------------------------------------------------------------------------------------------------|---------|-------|-----|
| 48 | Decomposition of zinc ferrite by roasting with ammonium chloride                                            | H. Kubo | • • • | 369 |
| 49 | Purification of the P-enriched phase derived from dephosphorization slag by roasting with ammonium chloride | H. Kubo | • • • | 370 |

### Effective application of the steelmaking slag and dust 2

|    |                                                                                                                                                                                                         |              |       |     |
|----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|-------|-----|
| 50 | Preparation of the high phosphate slag fertilizer<br>(Report of the workshop on the effective application of phosphate in the steelmaking slag 1)                                                       | T. Harada    | • • • | 371 |
| 51 | Survey of crops and qualification to utilize phosphate in the high phosphate slag for plant cultivation<br>(Report of the workshop on the effective application of phosphate in the steelmaking slag 2) | J. Wasaki    | • • • | 372 |
| 52 | Properties and effectiveness of the high phosphate slag fertilizer<br>(Report of the workshop on the effective application of phosphate in the steelmaking slag No. 3)                                  | M. Tani      | • • • | 373 |
| 53 | Field study of wheat cultivation using the high phosphate slag                                                                                                                                          | R. Kinoshita | • • • | 374 |

# Program of the 182<sup>nd</sup> ISIJ Meeting (September 2-4, 2021)

## Instrumentation, Control and System Engineering

| Lecture No.<br>Plenary Session | Title                                                                                                                                                  | Speaker      | Page      |
|--------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|-----------|
| <b>Instrumentation</b>         |                                                                                                                                                        |              |           |
| 54                             | Development of the shape meter for skin pass mill in continuous pickling line                                                                          | Y. Isei      | • • • 375 |
| 55                             | (ISIJ Research Promotion Grant) Imaging of magnetic characteristics using rectangular wave eddy current testing                                        | T. Sasayama  | • • • 376 |
| 56                             | The high sensitivity inspection technique for round billet using synthetic aperture focusing technique                                                 | K. Terada    | • • • 377 |
| <b>Process monitoring</b>      |                                                                                                                                                        |              |           |
| 57                             | Remote crane monitoring using area sensing technology                                                                                                  | I. Ishii     | • • • 378 |
| 58                             | Analysis of small displacement and deflection angle of overhead traveling crane using sampling moire method                                            | M. Fujigaki  | • • • 379 |
| 59                             | Vibration monitoring for unloader crane using high-speed vision                                                                                        | K. Shimasaki | • • • 380 |
| 60                             | Application of sphere frame drone to inspection of plant equipment                                                                                     | K. Ishiyama  | • • • 381 |
| <b>System and control</b>      |                                                                                                                                                        |              |           |
| 61                             | Anomaly detection system for hot strip mills<br>(Search technique for similar cases of troubles occurred in the past)                                  | Y. Harada    | • • • 382 |
| 62                             | Development of the proper stock model for the raw materials                                                                                            | H. Kobayashi | • • • 383 |
| 63                             | Development of a cooperative system with operators to support the determination of slabs charging order into heating furnaces in a steel plate factory | D. Inoue     | • • • 384 |

## Processing for Quality Products

| Lecture No.<br>Plenary Session                                            | Title                                                                                                                                                                                    | Speaker      | Page      |
|---------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|-----------|
| <b>Young engineer session of plate</b>                                    |                                                                                                                                                                                          |              |           |
| 64                                                                        | Expanded application of DBT rolling method, for improving the accuracy of rectangular geometry                                                                                           | T. Kawahara  | • • • 385 |
| 65                                                                        | Improvement in accuracy of target estimation for width of hot plate utilizing measured width of cold plate                                                                               | K. Inoue     | • • • 386 |
| 66                                                                        | Improvement of identification reliability for off-line plates by bar code verification                                                                                                   | S. Miyake    | • • • 387 |
| <b>Reliability evaluation of weld 3-1</b>                                 |                                                                                                                                                                                          |              |           |
| 67                                                                        | Numerical simulation of arc phenomena during arc spot welding with constricted nozzle                                                                                                    | H. Komen     | • • • 388 |
| 68                                                                        | Application of asymmetric Abel inversion to spectroscopic measurement of tilted TIG arc plasma                                                                                           | Y. Yamashita | • • • 389 |
| 69                                                                        | Simulation of nugget formation process during steel/Al-alloy dissimilar resistance spot welding by three-dimensional particle method and thickness estimation of intermetallic compounds | S. Chikuchi  | • • • 390 |
| 70                                                                        | Influence of external magnetic field in helium gas tungsten arc welding on molten metal flow and bead shape                                                                              | S. Matsuda   | • • • 391 |
| 71                                                                        | Microstructural evolution during wire arc additive manufacturing of martensitic stainless steel                                                                                          | Y. Sato      | • • • 392 |
| <b>Reliability evaluation of weld 3-2</b>                                 |                                                                                                                                                                                          |              |           |
| 72                                                                        | Microstructure and corrosion resistance of buried arc welds of stainless steels                                                                                                          | K. Kadoi     | • • • 393 |
| 73                                                                        | An identification of steel-weld microstructures by deep learning method and its interpretability                                                                                         | K. Tsutsui   | • • • 394 |
| 74                                                                        | Crystal plasticity simulation on the microscopic effect of loading history in fracture toughness test of welds                                                                           | Y. Mikami    | • • • 395 |
| 75                                                                        | Inhomogeneity and formation mechanism of microstructure in stir zone of friction stir welded duplex stainless steel                                                                      | T. Yamashita | • • • 396 |
| 76                                                                        | Effect of grain refinement on P segregation at grain boundary during friction stir welding                                                                                               | T. Kawakubo  | • • • 397 |
| <b>Modeling of various phenomena in metal forming and its application</b> |                                                                                                                                                                                          |              |           |
| 77                                                                        | Ductile fracture prediction in biaxial sheet stretching using the ellipsoidal void model                                                                                                 | K. Komori    | • • • 398 |
| 78                                                                        | Mechanism of surface defect generation caused by inclusions in slabs in hot rolling                                                                                                      | N. Yukawa    | • • • 399 |
| 79                                                                        | Prediction on diagonal cracks in outer rim of flange-shaped parts using an anisotropic ductile fracture model                                                                            | K. Hayakawa  | • • • 400 |

# Program of the 182<sup>nd</sup> ISIJ Meeting (September 2-4, 2021)

## Evaluation technology for mechanical properties of sintered materials

|    |                                                                                                                           |           |       |     |
|----|---------------------------------------------------------------------------------------------------------------------------|-----------|-------|-----|
| 80 | Persistent homology analysis for stomatal arrangement in porous materials-validation based on model arrangement           | Y. Ozaki  | • • • | 401 |
| 81 | Qualification of remained pore configuration in Ti6Al4V-MIM materials visualized by X-ray CT                              | Y. Ozaki  | • • • | 402 |
| 82 | Prediction and verification of solid solution strengthening effect of pure titanium sintered material with light elements | K. Kondoh | • • • | 403 |

## Control technologies for free cutting -14

|    |                                                                                                                           |             |       |     |
|----|---------------------------------------------------------------------------------------------------------------------------|-------------|-------|-----|
| 83 | (ISIJ Research Promotion Grant) Effect of finished surface properties after machining on nitriding process -First report- | M. Hagino   | • • • | 404 |
| 84 | Effect of C content in workpiece material on tool wear in hard turning                                                    | Y. Amano    | • • • | 405 |
| 85 | Influence of heat treatment on the machinability and finished surface residual stress of S55C steel                       | A. Takemura | • • • | 406 |
| 86 | Robust estimation for tool wear in turning processes for stainless steel                                                  | Y. Uchiyama | • • • | 407 |

## Recent tube forming young researcher's session IV

|    |                                                                                                                                                   |              |       |     |
|----|---------------------------------------------------------------------------------------------------------------------------------------------------|--------------|-------|-----|
| 87 | Effect of eccentricity on press bendability of eccentric pipe                                                                                     | K. Nakajima  | • • • | 408 |
| 88 | (ISIJ Research Promotion Grant) Effect of mandrel in semi-dieless drawing process for manufacturing variable thickness steel tubes                | T. Kishimoto | • • • | 409 |
| 89 | Measurement and analysis of elasto-plastic deformation behavior of cold rolled mild steel sheet subjected to non-linear stress paths (2nd report) | Y. Takada    | • • • | 410 |

## Surface and cooling

|    |                                                                                                               |           |       |     |
|----|---------------------------------------------------------------------------------------------------------------|-----------|-------|-----|
| 90 | (ISIJ Research Promotion Grant) Extension of treatable area by nitriding with atmospheric-pressure plasma jet | R. Ichiki | • • • | 411 |
| 91 | Boiling heat transfer characteristics of three upward circular water jets impinging on a moving hot sheet     | T. Hikata | • • • | 412 |

## Microstructure and Properties of Materials

### Lecture No.

| Plenary Session | Title | Speaker | Page |
|-----------------|-------|---------|------|
|-----------------|-------|---------|------|

### Electrical steel, titanium and its alloys

|    |                                                                                                                             |              |       |     |
|----|-----------------------------------------------------------------------------------------------------------------------------|--------------|-------|-----|
| 92 | Evaluation of IPM motor using Si gradient steel                                                                             | S. Yoshizaki | • • • | 413 |
| 93 | Effect of effective length on final grain radius of grain growth simulation based on the local curvature multi-vertex model | S. Morimoto  | • • • | 414 |
| 94 | Influence of chemical compositions on the thermal conductivity of $\alpha+\beta$ type titanium alloys                       | Y. Nakamura  | • • • | 415 |

### Heat resistant steels

|    |                                                                                                                             |               |       |     |
|----|-----------------------------------------------------------------------------------------------------------------------------|---------------|-------|-----|
| 95 | Creep strength and sensitization resistance of low C 18Cr-11Ni-3Cu-Mo, Nb, B, N steel                                       | N. Otaki      | • • • | 416 |
| 96 | Stability of Fe <sub>2</sub> Nb Laves and Ni <sub>3</sub> Nb phases in Zr containing novel austenitic heat resistant steels | S. Oh         | • • • | 417 |
| 97 | Creep strengthening of novel austenitic Laves steels by Ta replacement                                                      | Y. Mitsuya    | • • • | 418 |
| 98 | 3D observation of the precipitation behavior of KA-SUS304J1HTB at 973 K                                                     | T. Hatakeyama | • • • | 419 |

### Ni based alloys

|     |                                                                                                                                                                      |              |       |     |
|-----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|-------|-----|
| 99  | Change in dislocation density with tensile deformation of a additively manufactured Hastelloy X Ni base superalloy using In situ synchrotron diffraction in Spring-8 | S. Torizuka  | • • • | 420 |
| 100 | Microstructural characteristics and room and high temperature tensile properties of 3D printed Inconel 718 alloy                                                     | M. Obana     | • • • | 421 |
| 101 | Evaluation of the stability of $\gamma''$ -Ni <sub>3</sub> Ta (D022) phase at elevated temperatures                                                                  | T. Tsuya     | • • • | 422 |
| 102 | Computational study on phase equilibria among $\gamma$ /TCP/ $\sigma$ P6 phases in Ni-Cr-Mo ternary system at elevated temperatures                                  | R. Nagashima | • • • | 423 |

### Strength and deformation behavior 1

|     |                                                                                                                                                                           |             |       |     |
|-----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|-------|-----|
| 103 | Effect of nitrogen on work-hardening behavior at low temperature in stable austenitic steel                                                                               | R. Nakagawa | • • • | 424 |
| 104 | Formation of inhomogeneous microstructure in martensitic steel during cooling and its effect on yield strength -2                                                         | S. Yoshioka | • • • | 425 |
| 105 | Effect of cooling rate on carbon partitioning during quenching and partitioning process                                                                                   | T. Asakawa  | • • • | 426 |
| 106 | Effect of volume fraction, stability, and morphology of austenite of ultrafine ferrite + austenite structure on development of high strength and ductility of 1600MPa-30% | R. Iizuka   | • • • | 427 |

# Program of the 182<sup>nd</sup> ISIJ Meeting (September 2-4, 2021)

## Strength and deformation behavior 2

|     |                                                                                                      |             |       |     |
|-----|------------------------------------------------------------------------------------------------------|-------------|-------|-----|
| 107 | Effect of cold rolling on inhomogeneous deformation behavior and microstructure of Fe-Ni-Al-C alloys | Y. Kawano   | • • • | 428 |
| 108 | Effect of alloy compositions on microstructure during tensile deformation of Fe-Ni-Al-C alloys       | Y. Mori     | • • • | 429 |
| 109 | SEM-DIC analysis of slip deformation behavior based on simple shear                                  | K. Yasuda   | • • • | 430 |
| 110 | Formation of kink-like local deformation band in compressed pearlitic steels                         | K. Sugiyama | • • • | 431 |

## Hydrogen embrittlement 1

|     |                                                                                                                                                     |              |       |     |
|-----|-----------------------------------------------------------------------------------------------------------------------------------------------------|--------------|-------|-----|
| 111 | Evaluation of hydrogen entry into steel under atmospheric corrosive environment                                                                     | M. Kawamori  | • • • | 432 |
| 112 | Examination of hydrogen embrittlement behavior of ultrafine grain structured SUS316L steels by hollow high pressure hydrogen thin wall tensile test | Y. Ishii     | • • • | 433 |
| 113 | Hydrogen embrittlement properties of martensite-austenite dual-phase steels                                                                         | Y. Shibayama | • • • | 434 |
| 114 | The effects of the residual stress and plastic strain on the hydrogen embrittlement cracking in a stretch-formed tempered Martensitic steel sheet   | H. Nishimura | • • • | 435 |

## Hydrogen embrittlement 2

|     |                                                                                                                                                             |            |       |     |
|-----|-------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|-------|-----|
| 115 | Comparison of activation energy for hydrogen desorption of tempered martensitic steel including precipitated vanadium-molybdenum carbides                   | R. Moriya  | • • • | 436 |
| 116 | Effect of frozen-in vacancies on hydrogen-related intergranular fracture of pure iron                                                                       | R. Sato    | • • • | 437 |
| 117 | Crack initiation analyses in hydrogen embrittlement fracture of tempered martensitic steels with stress concentration                                       | N. Uemura  | • • • | 438 |
| 118 | Comparison of hydrogen embrittlement susceptibility followed by cyclic prestress of tempered martensitic steels with different stress relaxation properties | K. Kikuchi | • • • | 439 |

## Hydrogen embrittlement 3

|     |                                                                                                                                 |           |       |     |
|-----|---------------------------------------------------------------------------------------------------------------------------------|-----------|-------|-----|
| 119 | Evaluation of hydrogen embrittlement susceptibility using bend test and crack propagation analysis of high strength steel sheet | K. Tagawa | • • • | 440 |
| 120 | Hydrogen trapping sites in tempered martensitic steels with various tempering temperatures                                      | A. Nozaki | • • • | 441 |
| 121 | Numerical analysis of hydrogen concentration behavior under cyclic loading with an overload                                     | T. Ohmi   | • • • | 442 |
| 122 | Origin of serrated markings on hydrogen-related quasi-cleavage fracture in BCC steels                                           | K. Okada  | • • • | 443 |

## Stainless steel

|     |                                                                                                                           |              |       |     |
|-----|---------------------------------------------------------------------------------------------------------------------------|--------------|-------|-----|
| 123 | Relationship of between shear deformation and microduplex structure of duplex stainless steel                             | H. Nishimura | • • • | 444 |
| 124 | Age-hardening behavior of deformation-induced martensitic and austenitic single-phase steel wires added-N                 | S. Yamasaki  | • • • | 445 |
| 125 | Sliding wear properties and nanostructure in stainless steels                                                             | T. Yoshizawa | • • • | 446 |
| 126 | Effect of Nb and Ti on oxidation behavior in Al-containing ferritic stainless steel                                       | Y. Fujimura  | • • • | 447 |
| 127 | Effect of Al addition and bright annealing on high temperature sulfidation corrosion behavior of ferritic stainless steel | M. Sugeoi    | • • • | 448 |

## Quantitative analysis of microstructure

|     |                                                                                               |             |       |     |
|-----|-----------------------------------------------------------------------------------------------|-------------|-------|-----|
| 128 | Three-dimensional analysis of recrystallized ferrite grains in low-carbon steel               | K. Horiuchi | • • • | 449 |
| 129 | Quantitative analysis of cementite spheroidization in pearlitic steels by persistent homology | M. Suzuki   | • • • | 450 |
| 130 | Reconstruction of microstructure image by persistent-homology-based inverse analysis          | K. Kiyomura | • • • | 451 |

## Machine learning

|     |                                                                                                                            |              |       |     |
|-----|----------------------------------------------------------------------------------------------------------------------------|--------------|-------|-----|
| 131 | Bayesian optimization of parameters in cellular automaton simulation for ferrite phase transformation in carbon steel      | Y. Mino      | • • • | 452 |
| 132 | Development of microstructure recognition algorithm using machine learning for martensite/bainite two-phase microstructure | R. Takada    | • • • | 453 |
| 133 | Recognition of initiation site and fracture unit in brittle fracture surface of steel using machine learning               | M. Muramatsu | • • • | 454 |

## Partitioning of elements

|     |                                                                                                                                                                             |           |       |     |
|-----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|-------|-----|
| 134 | Grain boundary segregation of Mn during austenitization treatment in medium Mn martensitic steel                                                                            | T. Maeda  | • • • | 455 |
| 135 | Carbon enrichment of austenite during ferrite - bainite transformation in Fe-0.1C-0.5Si-2.0Mn steel                                                                         | S. Tanaka | • • • | 456 |
| 136 | Effect of carbon partitioning and carbide precipitation behavior on mechanical properties in metastable austenitic stainless steel with changes in partitioning temperature | R. Ogawa  | • • • | 457 |
| 137 | Effect of Si and Cr addition on temper softening resistance of 0.3%C martensitic steel                                                                                      | A. Ikeda  | • • • | 458 |



# Program of the 182<sup>nd</sup> ISIJ Meeting (September 2-4, 2021)

## Precipitation

|     |                                                                                                                                                    |             |       |     |
|-----|----------------------------------------------------------------------------------------------------------------------------------------------------|-------------|-------|-----|
| 138 | Coexistence of orientation relationships between ferrite and cementite in pearlite                                                                 | S. Endo     | • • • | 459 |
| 139 | Analysis of strengthening by Ti-N clusters and nano-sized TiN precipitate                                                                          | G. Miyamoto | • • • | 460 |
| 140 | (ISIJ Research Promotion Grant) High magnetic field effects on Cu-precipitation of Fe-1wt.%Cu                                                      | Y. Mitsui   | • • • | 461 |
| 141 | (ISIJ Research Promotion Grant) Crystal plasticity analysis of three dimensional GN dislocation distribution density in dispersion hardening steel | Y. Okuyama  | • • • | 462 |

## Surface technology

|     |                                                                                                                             |             |       |     |
|-----|-----------------------------------------------------------------------------------------------------------------------------|-------------|-------|-----|
| 142 | (ISIJ Research Promotion Grant) Experimental determination of phase equilibria in the Al-Fe-Si ternary system               | R. Kainuma  | • • • | 463 |
| 143 | Change in the three-phase eutectic microstructure of hot-dip Zn-Al-Mg alloy coating by heat treatments                      | T. Fukata   | • • • | 464 |
| 144 | Properties of liquid zinc embrittlement in pre-strained 490MPa class steels                                                 | M. Yamamoto | • • • | 465 |
| 145 | Water model experiment to clarify unplating caused by bubble generation in continuous galvanizing                           | M. Nakamoto | • • • | 466 |
| 146 | Corrosion resistance of rust layers on friction stir welded high phosphorus carbon steel                                    | K. Hatsuda  | • • • | 467 |
| 147 | (ISIJ Research Promotion Grant) Plasma characterization of low vacuum region of microwave-sheath voltage combination plasma | I. Tanaka   | • • • | 468 |

## Machine structural steel

|     |                                                                                                                    |             |       |     |
|-----|--------------------------------------------------------------------------------------------------------------------|-------------|-------|-----|
| 148 | Influence of fine particle peening on surface hardening microstructure of nitrided-quenched pure iron              | S. Watanabe | • • • | 469 |
| 149 | Effect of Cr amount on tempering softening resistance behavior in carbonitriding material                          | Y. Hayashi  | • • • | 470 |
| 150 | Spheroidized-carbide formation process below A <sub>1</sub> temperature in high-chromium steels for case-hardening | K. Matsuo   | • • • | 471 |
| 151 | Effect of quenching before spheroidizing annealing on ductile fracture limit of annealed steel                     | H. Narumiya | • • • | 472 |

## Process Evaluation and Material Characterization

Lecture No.

Plenary Session

Title

Speaker

Page

### Surface analysis and crystal structure analysis

|     |                                                                                  |           |       |     |
|-----|----------------------------------------------------------------------------------|-----------|-------|-----|
| 152 | Soft X-ray emission spectroscopy of carbon element in steel materials            | Y. Tanaka | • • • | 473 |
| 153 | Crystal structure analysis of Fe-C martensitic steels by ab-initio EBSD indexing | T. Tanaka | • • • | 474 |

### Non-destructive / on-site analysis for materials related to steel industry 1

|     |                                                                                       |             |       |     |
|-----|---------------------------------------------------------------------------------------|-------------|-------|-----|
| 154 | Analysis of Oxide growth mechanism by in-situ hydrogen measurement using a gas sensor | M. Fukumoto | • • • | 475 |
| 155 | Free lime content in steelmaking slag determined by cathodoluminescence imaging       | S. Imashuku | • • • | 476 |
| 156 | Characterization of aluminum oxide films formed on the surface of Fe-Ca-Al alloys     | S. Suzuki   | • • • | 477 |

### Non-destructive / on-site analysis for materials related to steel industry 2

|     |                                                                                                                                                       |           |       |     |
|-----|-------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|-------|-----|
| 157 | Pressure measurement beneath Oxide scale during high temperature oxidation of steel                                                                   | Y. Kondo  | • • • | 478 |
| 158 | Characterization of properties of Fe-based alloy melts                                                                                                | S. Suzuki | • • • | 479 |
| 159 | Precision of X-ray fluorescence quantification for non-destructive/on-site analysis and replacement of proportional counter by silicon drift detector | J. Kawai  | • • • | 480 |
| 160 | Terahertz non-destructive evaluation                                                                                                                  | T. Tanabe | • • • | 481 |



# Program of the 182<sup>nd</sup> ISIJ Meeting (September 15-17, 2021)

## ISIJ and JIM Joint Sessions

| Lecture No.<br>Joint Session                                                                | Title                                                                                                                                                                   | Speaker      | Page      |
|---------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|-----------|
| <b>Titanium and its alloys 1</b>                                                            |                                                                                                                                                                         |              |           |
| J1                                                                                          | In-situ analysis of TiAl alloy using X-ray fluorescence analysis                                                                                                        | T. Nishimura | • • • 482 |
| J2                                                                                          | Effect of transition metals on the mechanical properties and shape memory effect of the biocompatible Ti–Au–based alloys                                                | W. Chiu      | • • • 483 |
| J3                                                                                          | Anomalous grain size effect on the mechanical properties of Gum Metal                                                                                                   | T. Hashino   | • • • 484 |
| J4                                                                                          | Effect of alpha/beta orientation relationship on the deformation behavior in alpha+beta Ti-6Al-4V alloy                                                                 | E. Chandiran | • • • 485 |
| J5                                                                                          | Ultrafine-grain refinement makes Ti-O alloy ductile at 77 K                                                                                                             | Y. Chong     | • • • 486 |
| <b>Titanium and its alloys 2</b>                                                            |                                                                                                                                                                         |              |           |
| J6                                                                                          | Anormal phenomena of electrical resistivity in meta-stable beta type titanium alloys                                                                                    | M. Ikeda     | • • • 487 |
| J7                                                                                          | Precipitation behavior in two-step aging for Ti-Cu alloy                                                                                                                | H. Akamine   | • • • 488 |
| J8                                                                                          | Strain rate dependence on room temperature deformation in pure titanium                                                                                                 | M. Deguchi   | • • • 489 |
| J9                                                                                          | Inhomogeneous distribution of plastic strain in pure titanium                                                                                                           | Z. Song      | • • • 490 |
| J10                                                                                         | Numerical analysis of non-uniform deformation mechanisms in CP-Ti                                                                                                       | Y. Kawano    | • • • 491 |
| J11                                                                                         | Analysis of CRSS ratio and plastic-slip trace of a polycrystalline Ti-6Al-2Sn-4Zr-2Mo-Si alloy with controlling the grain size                                          | H. Matsumoto | • • • 492 |
| <b>Ultrafine grained materials -fundamental aspects for ultrafine grained structures-</b>   |                                                                                                                                                                         |              |           |
| J12                                                                                         | Wear and impact properties of harmonic structured composite with WC-Co alloy and high speed steel                                                                       | H. Fujiwara  | • • • 493 |
| J13                                                                                         | Microstructure formation and deformation behavior of Co-29Cr-6Mo alloy compacts                                                                                         | M. Kawabata  | • • • 494 |
| J14                                                                                         | Plastic deformation propagation behavior in grain size gradient regions based on atomistic and dislocation studies                                                      | K. Kiyota    | • • • 495 |
| <b>Materials science of martensitic and bainitic transformations and its applications 1</b> |                                                                                                                                                                         |              |           |
| J15                                                                                         | Effect of thermomechanical treatment on recrystallization and quenched structure of medium Mn steel                                                                     | K. Matsuda   | • • • 496 |
| J16                                                                                         | Changes in solute carbon concentration and toughness during low-temperature tempering in martensitic carbon steel containing retained austenite.                        | S. Uranaka   | • • • 497 |
| J17                                                                                         | Effect of reduction rate / pass in controlled rolling on the properties and texture of bainite structure                                                                | N. Takayama  | • • • 498 |
| J18                                                                                         | Relationship between heterogeneous carbon distribution in bainite and austenite microstructure and thermal stability of austenite                                       | M. Watanabe  | • • • 499 |
| <b>Materials science of martensitic and bainitic transformations and its applications 2</b> |                                                                                                                                                                         |              |           |
| J19                                                                                         | Anisotropy of cleavage fracture caused by transformation internal stress in martensitic steels                                                                          | D. Fukui     | • • • 500 |
| J20                                                                                         | TRIP effect via $\gamma \rightarrow \epsilon \rightarrow \alpha'$ transformation and reverse $\epsilon \rightarrow \gamma$ transformation in Fe-15Mn-10Cr-8Ni-4Si steel | T. Sawaguchi | • • • 501 |
| J21                                                                                         | Fatigue crack growth associated with microstructural evolution under cyclic loading in nano-twinned SUS304 steel                                                        | Y. Mine      | • • • 502 |
| J22                                                                                         | 3D-EBSD analysis for microstructural fatigue crack propagation in lath martensite of carbon steel                                                                       | S. Ueki      | • • • 503 |
| <b>Materials science of martensitic and bainitic transformations and its applications 3</b> |                                                                                                                                                                         |              |           |
| J23                                                                                         | Effect of dislocation density on strength and ductility in low carbon – 2%Si - 5%Mn fresh martensitic steel                                                             | A. Ito       | • • • 504 |
| J24                                                                                         | Development of 1800MPa-13% by the formation of ultrafine equiaxed martensitic structure in low carbon 7Mn steel                                                         | R. Oya       | • • • 505 |
| J25                                                                                         | Effect of Al content on functional fatigue in Fe-Mn-Al-Ni superelastic alloys                                                                                           | T. Hoshi     | • • • 506 |
| J26                                                                                         | Temperature dependence of critical stress in Cr added Fe-Mn-Al-Ni based superelastic alloys                                                                             | J. Xia       | • • • 507 |
| <b>Materials science of martensitic and bainitic transformations and its applications 4</b> |                                                                                                                                                                         |              |           |
| J27                                                                                         | Dislocation microstructure analysis of deformation-induced martensite in metastable austenitic steel                                                                    | Y. Kaya      | • • • 508 |
| J28                                                                                         | Change of phase transformation temperature by shot-peening for Fe-33%Ni and Fe-28%Ni-20%Co alloys                                                                       | H. Sato      | • • • 509 |
| J29                                                                                         | Phase-field analysis of change in dislocation density during martensitic transformation in steel                                                                        | R. Yamazaki  | • • • 510 |

# Program of the 182<sup>nd</sup> ISIJ Meeting (September 15-17, 2021)

## Materials science of martensitic and bainitic transformations and its applications 5

|     |                                                                                       |              |       |     |
|-----|---------------------------------------------------------------------------------------|--------------|-------|-----|
| J30 | Microstructure and martensitic transformation behavior of Ti-Pd-Hf alloys             | K. Kiwaki    | • • • | 511 |
| J31 | Morphology and crystallography of self-accommodation of martensite in Ti-Ni-Hf alloys | N. Maeda     | • • • | 512 |
| J32 | Variant pairing of lenticular martensite at $\Sigma 3$ boundaries                     | Y. Shinohara | • • • | 513 |
| J33 | Effect of B2 precipitates on martensite transformation behavior in Fe-Ni-Al alloys    | T. Moritani  | • • • | 514 |

## Materials science of martensitic and bainitic transformations and its applications 6

|     |                                                                                                                                         |           |       |     |
|-----|-----------------------------------------------------------------------------------------------------------------------------------------|-----------|-------|-----|
| J34 | Effect of cooling rate on microstructures in Fe-Ni martensite                                                                           | S. Morito | • • • | 515 |
| J35 | Three-dimensional observation of the microstructure of upper bainite nucleated from grain boundaries in medium carbon steel             | S. Jimbo  | • • • | 516 |
| J36 | Relationship between lattice parameters and crystallographic characteristics of stress-induced martensite in Ti-base shape memory alloy | M. Tahara | • • • | 517 |
| J37 | Cryogenic shape memory effect in Cu-Al-Mn alloys                                                                                        | S. Sato   | • • • | 518 |

## Materials science of martensitic and bainitic transformations and its applications 7

|     |                                                                                                  |             |       |     |
|-----|--------------------------------------------------------------------------------------------------|-------------|-------|-----|
| J38 | Reentrant martensitic transformation and phase equilibria in Co-Cr-Ga-Si alloys                  | R. Murakami | • • • | 519 |
| J39 | Displacive phase transformation in Mn-Zn-based alloys                                            | X. Xu       | • • • | 520 |
| J40 | Tempering-induced martensite in Ti-10Mo-7Al alloy                                                | Y. Takemoto | • • • | 521 |
| J41 | Resistance to temper softening in low carbon martensitic steels by microalloying of V, Nb and Ti | Y. Zhang    | • • • | 522 |

## Materials science of martensitic and bainitic transformations and its applications 8

|     |                                                                                                                                          |             |       |     |
|-----|------------------------------------------------------------------------------------------------------------------------------------------|-------------|-------|-----|
| J42 | Effect of Co concentration on hysteresis for martensitic transformation in (Ni-Co) <sub>50</sub> -Mn-Sn metamagnetic shape memory alloys | T. Miyakawa | • • • | 523 |
| J43 | Metamagnetic transition in Pd <sub>2</sub> MnGa-based alloys                                                                             | T. Ito      | • • • | 524 |
| J44 | Microstructural evolution of martensitic steel sheet containing auto-tempered martensite                                                 | Y. Wada     | • • • | 525 |
| J45 | Excess solute carbon and retained tetragonality after the tempering of 0.6%C martensitic steels                                          | N. Maruyama | • • • | 526 |