欧文会誌への投稿の勧め ∞∞∞∞∞∞∞∞∞∞∞∞∞∞∞∞∞∞∞∞∞∞∞∞

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If you are interested in submitting a paper and would like to receive more information, the editorial section is glad to help you on any point of difficulty.

The Editorial Committee of the Transactions of
the Iron and Steel Institute of Japan

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欧文会誌投稿規程改定のおしらせ∞∞∞∞∞∞∞∞∞∞∞∞∞∞∞∞∞∞

1987年 1月より欧文会誌(Transactions of the Iron and Steel Institute of Japan) の投稿規程(Instructions for Contributors) を改定することになった。同時にて執筆要領(Preparation of Manuscript)を A Guide for Preparation of Manuscriptとして整備した。その目的はSI単位の使用、Key words の採用など必要な改定を機に、非原著報文の取扱いなどの編集方針の明示、および原稿作成上の注意事項などの周知により一層の効果的かつ効率的な編集刊行を推進するためである。新しい投稿規程と執筆要領はこの後のページに、またTrans. ISIJ1987年各号巻末に掲載される。ここではさらに、規程内容の充分な理解に役立つことを願い、それらの和文解説版“原稿執筆投稿の手引き”を付した。主要な改定項目は次ぎに列記した。

(1) SI単位の奨用----1990年実施予定の鉄鋼協会全刊行物のSI単位系移行に備え、欧文会誌ではSI単位系の使用を奨励する。奨用される基準、誘導および併用単位系を“手引き”の付録に示した。

(2) Key words の採用----会誌掲載報文の内容が効果的に情報検索されるよう、著者がKey wordsを選定し、それらをSynopsisとともに掲載する。その選定要領は“手引き”とその付録の基準語句集を参照されたい。

(3) Synopsis----長さは 250語以内（ダブルスペースでタイプしたA4判用紙一枚相当）とする。Synopsisが報文を代表しかつ独立した抄録であることを配慮した簡潔明瞭な記述が必要である。

(4) Figure(Drawing) とPhotographの区別廃止----すべての図および写真はFigureとして一連番号をつける。各Figureは一枚のA4判用紙に描記または貼付する。Figure captionは必らず別紙にまとめてタイプし、Caption listとして提出する。

(5) 版権譲渡----原稿の投稿をもって、掲載に至った場合、その版権の鉄鋼協会への譲渡表明と見なす。また既版権物の使用許可取得は投稿者の責任とする。

(6) 非原著報文の取扱い----Trans. ISIJは“鉄と鋼”の姉妹誌として、原著(original work) 論文あるいは報告を掲載刊行している。しかしその創刊の趣旨にのっとり和文にて既刊の非原著報文でも、それが国外向け発表の高い価値をもつと判断される場合には、その英文版を転載してきている。この和文と英文との二重投稿を容認する編集方針を明示するとともに、国外向け発表価値の審査の参考となる英文版転載希望理由書提出を著者に求めることとする。また従来どおり、投稿者は既発表の有無をApplication Formにおいて申告、署名確認する。

(7) Research Note ----新知見あるいは新手法など速報に値するものには、とくに迅速な編集処理を配慮する。さらに若手研究者の発表の場として提供し、そのための特別な配慮がなされるので、Research Note として短報の投稿を期待する。

(8) Review----Review記事は編集委員会から執筆を依頼する。また編集委員会は執筆希望者からのReview題目提案を歓迎する。

(9) 従来慣行の明文化----著者に周知し修正や照会に浪費する時間・労力をなくすための注意事項。

(a) Title: 連報、副題は認めない。　　(b) 用語: 商品名、社内用語は使わない。

(c) 略語: 一般化されていない略語は、初出時に明確な定義を与える。

(d) 引用文献: REFERENCESには未刊行および非公開の資料、私信を含めることはできない。

その他の事項を含め、詳細は添附の資料をよく参照していただきたい。規程・要領および手引きに従った注意深い原稿作成は早期掲載につながる。貴重な成果を広く世界に知れわたらすメディアとして欧文会誌を活用していただき、さらに多数の投稿の寄せられることを歓迎する。

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INSTRUCTIONS FOR CONTRIBUTORS

(Revised in January 1987)

Authors are advised to observe the following Instructions and Guide. Careless preparation of manuscript wastes time in reviewing and editing and, moreover, tends to create bias against the scientific validity of the work being reported. The Editor reserves the right to return to the author any manuscript that does not conform to the standard cited below.

1. Scope: The Transactions of the Iron and Steel Institute of Japan (Trans. ISIJ) is an official monthly journal of the Iron and Steel Institute of Japan, devoted to publishing significant and original works of research, development, or engineering in a multidisciplinary area of current importance to the international ISIJ membership.

2. Policy: Papers on original material are invited for consideration of publication from both members and non-members of any nationality. The Institute has a policy of not making publication charges to the authors. Rapid publication is also its sincere intention by keeping the time for processing of submitted manuscripts to the minimum consistent with the high quality of papers. In return the authors are expected to assume the responsibility for minimizing editorial costs by preparing the satisfactory material that can be published as effectively and as efficiently as possible for the benefit of authors, editors, and especially readers.

As the formalities on application for publication, the representative author should provide **signed assurance** that the paper or its equivalent has neither been copyrighted, published, nor submitted for publication elsewhere; Application Form is available in every issue of the journal.

However, it is the aim of the Institute to publish worthy material not otherwise available to worldwide publicity. Occasional contributions of special merit will be accepted if previous publication is unlikely to come to the attention of international readership; the publication includes appearance in a journal of limited circulation or in the Japanese language. Materials previously published in abbreviated form as a paper in conference proceedings or as Research Note can be the basis of a regular article in the journal, provided the submitted manuscript presents considerably more details which enables the reader to get a substantially improved understanding of the subject. In such cases, the article should be so referenced in the Application Form; the author is also requested to submit a rationale for the duplicate publication and to furnish a copy of the previous paper.

An article reports the result of a completed definitive study. Fragmentation of a substantial body of work into serial reports is strongly discouraged; the use of series title or subtitle is prohibited.

3. Copyright: The submission of a paper is considered that, if accepted for publication, copyright in the paper will be transferred to the Iron and Steel Institute of Japan. The Institute will not refuse any reasonable request by the authors for permission to reproduce any of their contributions in the journal. Only the rejected manuscript will be returned to the author.

If any portion of a paper, including figures or tables, has been drawn from another copyrighted source, the author must submit to the Editor written permission from the copyright holder for its reproduction.

4. Reviewing: The Editor of Trans. ISIJ reserves the ultimate right of acceptance or rejection of a submitted paper. Every manuscript receives reviewing. A paper cannot be rejected on the judgement of a single reviewer. The criteria for acceptance are the importance in scientific or technological contribution, the originality or usefulness in idea or method, the accuracy and validity of results, the interest of the topic to the membership, and the quality with regard to arrangement, clarity, and brevity in conformance to the Instructions. The author will be informed of the comments and suggestions of reviewer indicating whether the paper is acceptable for publication without change or with mandatory or optional revisions. Authors are expected to respond to the comments by revising the manuscript in accordance with the comments and by replying in an accompanying letter to the points that the authors think to be not valid.

5. Language and Style: The language of the journal is **English** as an international scientific language; latitude in the spelling, English or American, is allowed, but consistency is required in a paper. The use of **SI units** is standard; the non SI units approved for use with SI are acceptable. It is the policy of ISIJ to adopt SI units exclusively in all publications after 1990. Jargons and trade names or anything that might constitute advertising must be avoided. All nonstandard abbreviations and symbols should be defined at their first introduction in the text. Italics, subscripts, superscripts, and Greek letters, especially those easily confused with English letters, must be clearly indicated.

The author may use an individual writing style, but the paper should be clear, coherent, concrete, and correct, and, as far as compatible with these requirements, be concise. The editorial staff and grammatical reviewer will correct errors, but the author

himself must ensure the accuracy of proper nouns, technical terms, numerical data, and mathematics. It should not be expected for the editors or reviewers to undertake the task of rewriting the paper for correcting inadequacies of language. A critical review by coworkers and colleagues before submission of a paper is strongly suggested.

6. Categories: The first four categories are open to general contributors. Authors are requested on submission to indicate the category intended. Should this seem unsuitable, the Editor will inform the author.

(i) Research Article: A full length original paper that presents experimental results or theoretical studies of significance or novelty together with clear analysis and discussion of the results.

(ii) Technical Report: A paper that presents (a) new progress in the field of practical engineering, such as design, construction and operation of plant and equipment, new developments of production process, controlling system, and instrumentation, or (b) compilation of practically significant data by simulation and modeling, both preferably with quantitative interpretations of the underlying principles related to the work.

(iii) Research Note: A short article on a new finding, a research technique, or interesting aspect of ongoing study, insufficiently detailed but sufficiently important to merit prompt preliminary publication in condensed form.

Particular attention will be given to junior researchers and graduate students submitting materials in this category.

(iv) Letter to Editor: A medium for the presentation of (a) criticisms or additional proofs and interpretations in connection with the materials previously published in the Institute journals or (b) opinion or proposal of interest to the members engaged in any phases of science, technology or education.

(v) Review: Review Articles are published by invitation; prospective authors are also encouraged to contact with the Editor on proposed subject material.

(vi) Miscellaneous: The journal publishes a limited number of Special Lecture, ISIJ Activity Report, and New Technology, which are specially commissioned by the Editor.

7. Length: A formal limit is set for the length of a paper of each category: ten journal pages for Research Article and Technical Report, four pages for Research Note, and two pages for Letter to Editor. Shorter papers are encouraged regardless of the limit. Overlong paper may be returned to the author for condensation prior to review. However, the Editor may justify a longer paper of high quality that deserves special consideration.

A journal page is approximately 1 000-words equivalent: an average of eight words in one line arranged in two columned 62 lines. A figure is reduced to the column of 82-mm breadth; the largest size of a figure allowed on a journal page, 110 mm×82 mm, is equivalent to 250 words.

8. Reprint: The author will be presented with twenty copies of courtesy reprints upon publication. Further copies can be ordered at a reasonable cost that depends on the length of the paper. The order form will be sent with the proofs.

The Editorial Committee of Trans. ISIJ, ISIJ

A Guide for Preparation of Manuscript

(Revised in January 1987)

1. Typescript: The typescript must be presented in the order: (1) title page, (2) synopsis and key words, (3) text, (4) references, (5) appendices, and (6) list of captions, each of which should start on a new page. The sheet must be numbered consequtively, with the title page as page 1. All the sections must be typewritten, double spaced throughout, on one side of A4 paper with ample margins all around.

(1) The **title** page must contain only the title, the full name, affiliation, and mailing address of each author. The title should be carefully chosen to be an accurate and objective description of the work in a minimum number of words. Introductory phrases such as " On the . . . " or " Study of . . . " are ordinarily unnecessary.

(2) A **synopsis** must state briefly and clearly the main object, scope, and findings of the work within **250** words; it must be complete and intelligible in itself, since it will appear separately in abstract publications. The synopsis should give a reader sufficient incentive to decide to read the whole paper.

Several **key words** are required to accompany the synopsis for secondary information retrieval. These terms must be relatively independent and as a group should optimally characterize the paper.

(3) The **text** must include sufficient details to enable others to repeat the work. The experimental procedure must be clearly described; however, methods should be given in detail only if they represent a new approach. Extensive survey of the literature is not necessary in an original paper. Conclusions are convictions based on the evidence presented.

(4) **Reference** information should be complete in order that the reader is able to retrieve the reference cited. References must be numbered in one consequtive series. Reference numbers in the text must be typed as superscripts with a closing parenthesis, for example[1]. Refer to authors by surname only in text; if a reference has two authors, give both names; if a reference has more than two authors, give only the first name listed and followed by *et al.*

The full list of references should be typed double spaced on a separate page and placed at the end of the text; list the names of all authors in the form in which they appear on the title page of the cited work with the surname last.

(a) Unpublished work: Biographic references to classified or unpublished material not commonly available to the publicity should be avoided. Personal communications and articles not yet accepted for publication are not acceptable references. They must be given as footnotes or in Acknowledgement. If the submission depends on unpublished work, a copy of the unpublished work should be included to assist the evaluation by reviewers.

(b) Styling of References: The original publication in non Roman characters should be given in English translation or transliterated into the Roman alphabet.

1) Style for journal: names of all authors, first initials followed by surname, journal title in the standard abbreviation, volume number, year of publication in parentheses, issue number when each issue is paginated separately, and initial (serial) page. If in doubt of the abbreviated journal title, authors are requested to spell out the title in full.

I. Ohnaka and K. Kobayashi: *Trans. ISIJ*, **26** (1986), 781.
Y. Hisamatsu: *Tetsu-to-Hagané*, **72** (1986), 889.

2) Style for book: author, title, editor, publisher and location, year, initial page.

H. Takechi, M. Matsuo, K. Kawasaki and T. Tamura: Proc. of the 6th Int'l Conf. on Textures of Materials, ISIJ, Tokyo, (1981), 209.
W. C. Leslie: The Physical Metallurgy of Steels, McGraw-Hill, New York, (1981), 151.

(5) **Appendices** may be used for mathematical details, descriptions of apparatus, and other related materials not essential to the main discussion of the subject.

2. Table: Tabulated data should not be duplication of the values detailed in the text or on graphs. A small amount of data, such as the composition of an alloy, can be incorporated in the lines of the text. Tables must not appear in the text but should be prepared on separate sheets. They must have captions and simple column headings.

3. Figure: All graphs, charts, drawings, diagrams, and photographs are to be referred as Figures (abbreviated as Fig. except at the beginning of a sentence) and should be numbered consequtively in the order that they are cited in the text. They must appear on a separate sheet for each figure. Each figure should be identified by the author's name, figure number, and caption. Figures must be photographically reproducible. The Institute has no facilities for redrawing of figures; poor quality figures will be returned to the authors for redrawing.

(a) Each figure should be given a self explanatory caption. To aid the printer in publication, a separate list of figure captions is required. Figure captions must be collected, numbered, and typed double spaced on separate sheets.

(b) Photographs should be glossy prints not exceeding 210 mm × 160 mm. A photograph should be pasted firmly on a hard sheet. When several photographs are to make up one presentation, they should be ar-

ranged without leaving margins in between and separately identified as (a), (b), (c) . . . The photomicrograph must be prepared with magnification by inscribing a scale.

(c) Line drawings must be drafted with black ink on white drawing paper no larger than 260 mm × 160 mm, with careful lettering large enough to remain legible after reproduction. Glossy prints of drawings are only acceptable if of high quality, well focused, showing no blurred or broken parts. Graphs should be framed and inscribed with appropriate graduation lines. The axes should be identified with the nomenclature of the parameter or variables concerned, its symbol, and unit.

(d) Figures should be designed for final printing in single column 82 mm width. The standard width of a line is 0.4～0.5 mm for ordinary lines and approximately 0.2 mm for fine lines. The maximum height of letters or numerals is 4.5 mm (18 points), and they should be scribed in black by using a mechanical means. Ordinary typewriter letters are unacceptable as they are too small for clear reproduction.

(e) Color printing of photographic material can be arranged, if the editor and reviewer judge it to be necessary for the proper presentation. Authors or their institutions must bear the cost.

(f) Proper places of insertion should be indicated in the right-side margin of text.

(g) Low quality computer-generated graphics or charts are not acceptable.

4. Submission of Manuscript: The original and one copy of a manuscript, both complete with application form, title page, synopsis and key words, text, references, list of captions, tables, and figures, should be sent in:

The Editorial Committee of Trans. ISIJ
The Iron and Steel Institute of Japan
Keidanren Kaikan 3rd Floor
9-4, Otemachi 1-chome, Chiyoda-ku,
Tokyo 100, JAPAN

One set of figures should be of a superior quality for direct reproduction for printing.

5. Revising of Manuscript: A manuscript returned to an author for revision must be returned within **three months** if it is not to be considered as a new manuscript. The typescript and one clear copy of the revised manuscript should be submitted. Revisions and ammendments must be inserted by type writing; in most cases, complete retyping of the pages affected by revision is necessary.

6. Proofreading: Representative author will receive a galley proof of his article. It is essential that the author returns the proof as quickly as possible with minimum alterations. Major alterations to the paper are prohibited.

The Editorial Committee of Trans. ISIJ, ISIJ

TRANSACTIONS OF THE IRON AND STEEL INSTITUTE OF JAPAN

原稿執筆投稿の手引き

1．はじめに

本手引きは、TRANS. ISIJ の投稿規程 (Instructions for Contributors) の補足として、著者に執筆・投稿に際して注意していただきたいことを記したものである。ここに示された要領に従って執筆・投稿していただくことにより、編集・審査・印刷などの諸手続きが円滑に進み、早く掲載される。原稿の作成が不注意になされていると、編集者、審査員そして刊行された場合の読者に時間の浪費を強いることになる。そのために、掲載の遅れ、報告内容の価値への疑義を生じることになる。

2．原稿の受付、受理

2．1．受付

規程に示す必要なものが整えられた原稿が本会に到着した日を受付日とする。

【必要なもの】

(1) Application for Publication in TRANS. ISIJ
(既発表の有無を明記)

(2) 原稿 (正副一通ずつ)
規程ページ: Research Article - 刷り上がり１０ページ以内
Technical Report - 刷り上がり１０ページ以内
Research Note - 刷り上がり４ページ以内

(3) ２５０語以内の英文要旨

(4) 和文として既発表の報文を英文版として転載を希望する場合には、所定の書式による転載希望理由書

2．2．修正、再受付

修正期間は、原則として１か月とする。修正箇所は明確にし、新たにタイプし直す。返送指定日より２か月の猶予期間（事務局発送日より通算３か月）を経過しても修正原稿の提出がない場合は、原稿の取下げとみなす。
修正期間（猶予期間を含む）満了時に返送された修正原稿は新規投稿として取扱い、原稿が本会に到着した日を新たな受付日とし、会誌にはこの年月日を記入する。

2．3．受理

欧文会誌分科会における審査の結果、掲載可の判定を得た日を受理日とする。

2．4．校正

掲載号発行の１．５カ月前に、著者による校正を求める。その際は、速やかに校正し、印刷上の誤り以外の書き改めは、原則として認めない。

2．5．別刷

別刷は、掲載号発行後無料で２０部提供する。それ以上を必要とする場合は、校正時所定の用紙に必要事項を記入の上申し込む。

3．原稿の構成

3．1．Title

最初のページにTitle、全著者のフルネーム、所属、住所を記入する。
Titleは、内容を簡潔で具体的な表現により、著者が最も重要なものとして取り上げた事項を、的確に示したものとする。連報形式および副題は用いない。On...., Study on....はつけず、また商品名、略号は避ける。
審査過程においてTitleの修正を行なった場合、本文中の表現との整合も必要である。

3．2．Synopsis
論文・報告の目的とその範囲、研究の手段や方法、重要な新しい事実・現象などの結果、その解釈と導かれる結論を、本文、図、表を参照せずに理解できるように明確に示した著者抄録である。したがって、結論（Conclusion）とは異なり、第三者から見た客観的表現をとる。SynopsisはTitleに常に伴なうものであるから、Titleの内容をくり返す必要はなく、Titleで不十分な時の副題的表現にとどめる。
Synopsisのみで独立し完成した形とし、本文が読むべきものであるかどうかの判断の基準を与え、また抄録誌にそのまま転載されるものであるから、内容のオリジナルを明確に示す密度の高い記述が必要である。

3．3．Key words
Synopsisの下にKey words: として、論文の内容を代表する重要な術語を、数語句選んで記載する。付録の基準Key words集の中から、まず一ないし二語句を選定する。さらにTitleおよびSynopsisの中から、内容の特徴を表わす研究対象、素材、特性、手法などに関する具体的な語句を選ぶのが望ましい。当然すぎるため、もれた語句がないかを注意する必要がある。
各語は固有名詞などを除き、小文字で記し、語間をセミコロンで区切る。名詞は、単数形とし、原則として省略形は使用しない。

3．4．Text
International scientific languageとしての標準的英語を用い、一論文中では米式または英式のいずれかに統一する。内容の適切な伝達のために、表現、スタイル、用語において、clear, coherent, concise, concrete and correctであり、構成においてもcomplete and courteousであることが望ましい。
使用単位は、SIとし、SI併用単位（min, h, L, tなど）も許容される。付録のSI単位表を参照のこと。

（1）Introduction
主題の範囲と内容を明らかにして、著者の問題を解明していく観点を述べる。そのために、問題の背景を必要最小限簡潔に記述する。

（2）Experimentals、Results and Discussion
イ）実験研究の場合については、材料・方法について追跡実験が可能なように記述する。
ロ）使用材料あるいは装置については、商品名、商標の使用を避け、特徴・機能など具体的に示す。
ハ）理論解析においては、理論式の導出が理解できるように示し、チェックできる数値解析結果を添える。複雑で長い取扱いを必要とする場合にはAppendixとする。
ニ）実験データは、重点的にFigure、textとに重複なく示し、Figureの使用は最小限度にとどめる。
ホ）新しい概念や術語は、初めに明確に定義する。
ヘ）略語は、初出の時にフルスペリングにて示す。
例: Thermo-mechanical Control Process (TMCP)
ト）独自の理論、新知見、解釈などオリジナリティーを明確に定義する。
チ）論旨を一貫してスムーズに進める。
リ）ギリシャ文字、イタリック、上つき、下つきを明確に指示する。

（3）Conclusion
Discussionの章で提示した重要な新しい知見を明瞭に述べる。得られた結果から推論される結論とその妥当性を簡潔に示す。今後の展開の方向についての考えを述べるのもよい。

3．5．REFERENCES
原著論文では、関連論文を網羅的に引用する必要はない。論文の内容と直接に関係するものだけに限り、もれなく引用、言及する。
引用文献は、既に発表されており、一般に入手可能なものに限る。私信（private communications）および未刊行論文（to be published）からの引用は、本文中にまたは脚注としてその出所と内容の概略を示す。非公開の日本鉄鋼協会共同研究会等の資料については引用しない。掲載済決定（in press）のものを重要な文献として使用する時はその原稿を審査資料に添えて投稿することが望ましい。

(1) 本文中に文献の著者名を引用する場合は、姓だけを書く。本文中では、著者が2名までの場合には必ず2名とも姓を記し、3名以上の場合には、第一著者名以外をet al.で示す。
(2) 引用文献は、本文の該当箇所の右肩に上ツキ数字で1)、2-5)のように表わす。
(3) REFERENCES は、別紙に引用順にダブルスペースでタイプする。
(4) REFERENCES においては、共著者が多数の場合でも省略せず、全部列記する。
(5) 同じ文献を連続して引用する場合でもibid. を使わない。
(6) REFERENCES の引用の仕方は、次の通りとする。

【例】I. Ohnaka and K. Kobayashi : Trans. ISIJ, 26 (1986), 781.

Y. Hisamatsu : Tetsu-to-Hagané, 72 (1986), 889.

W. C. Leslie : The Physical Metallurgy of Steels, McGraw-Hill, New York, (1981), 151.

(学振の引用方法: ただし、投稿者は、原著者及び学振から許可を得ること)
Authors' names: The 54th Committee (Ironmaking), the Japan Society for the Promotion of Science (JSPS), Rep. No. 1234 (Jan., 1981).

4. Figure、Table
(1) Figure、Tableには、それぞれcaption を付け、caption list を作成する。
(2) 本文原稿右余白に、Figure、Table の挿入位置を記入する。Figure、Tableには右下隅に代表著者名を記入する。
(3) Figure、Tableは、A4判用紙1枚に一つずつ書くか、貼る。
(4) 図、グラフ、写真はFigureとし、通し番号を付ける。
(5) 作成要領の詳細は、 A Guide for Preparation of Manuscript を参照のこと。
(6) カラー写真は、編集委員会において必要と認めた場合、著者の実費負担により掲載できる。
(7) 既発表のFigure、及びTable の使用が必要な場合は、著者自身が版権所有者からの転載許可を得る。

以 上

(社) 日本鉄鋼協会編集委員会欧文会誌分科会

A List of Key Words

This list is intended to offer assistance in the selection of key words, but not to cover all items. The scheme is classified in the following five categories, (a) to (e), as the widest possible spectrum for optimal characterization of the principal subject of paper. The listed entry terms represent a generically broader class and are accompanied by one or two narrower terms, by way of example, in the subordinate heading. The use of narrower term is preferred for the entries with asterisk.

(a) Production and Fabrication: process and equipment

Direct reduction
  Hydrogen reduction . . .
Agglomeration
  Pelletizing . . .
Ironmaking
  Blast furnace process . . .
Hot metal treatment
  Hot metal desulphurization . . .
*Steelmaking
  Basic oxygen steelmaking
  Electric arc steelmaking . . .
Secondary steelmaking
  Vacuum degassing . . .
Ingot making
  Capped steel . . .
Continuous casting
  Continuous casting machine . . .
Hot rolling
  Plate mill . . .
Cold rolling
  Skin pass rolling . . .
Heating
  Radiant heating . . .
Cooling
  Splat cooling . . .
Heat treatment
  Tempering . . .
Protective coating
  Electroplating . . .
Foundry
  Die casting . . .
Forging
  Press forging . . .
Drawing
  Wire drawing . . .
Press forming
  Deep drawing . . .
Welding
  Shielded metal arc welding . . .
Powder metallurgy
  Mechanical alloying . . .

(b) Materials and Products

Iron ore
  Hematite . . .
Refractory
  Basic refractory . . .
Coal
  Pulverized coal . . .
Coke
  Metallurgical coke . . .
Fuel
  Petroleum . . .
Slag
  Blast furnace slag . . .
Ferroalloy
  Ferrosilicon . . .
*Alloying element
  Microaddition of titanium
  Austenite former . . .
Cast iron
  Malleable iron . . .
*Semi-finished steel
  Billet
  Steel slab . . .
Plate
  Boiler plate . . .
Hot rolled product
  Controlled rolled steel sheet . . .
Cold rolled product
  Drawing quality sheet steel . . .
Shapes
  Wide flange beam . . .
Bar and rod
  Wire rod for cold heading . . .
Wire
  Piano wire . . .
Tubular product
  Seamless tube . . .
Welded tubular product
  Electric-welded pipe . . .
Precoated product
  Galvanized sheet . . .
Castings
  Centrifugal castings . . .
Forgings
  Upset forgings . . .
Low carbon steel
  Drawing quality steel sheet . . .
Carbon steel
  Carbon steel for structural use . . .
Low alloy steel
  Chromium molybdenum steel . . .
High strength low alloy steel
  Niobium microalloyed steel . . .
Ultrahigh strength steel
  Maraging steel . . .
Tool steel
  High speed tool steel . . .
Electrical steel
  Grain oriented silicon steel . . .
Stainless steel
  Austenitic stainless steel
  Ferritic stainless steel . . .
Steel for elevated temperature service
  Chromium-molybdenum steel . . .
Steel for low temperature service
  Manganese steel for cryogenic use . . .
Superalloy
  Nickel base superalloy . . .
Titanium base alloy
  Beta titanium alloy . . .
Nonferrous metal
  Aluminum . . .
Ceramics
  Silicon nitride . . .
Composite material
  Fiber composite . . .
*Special-purpose material
  Superconducting material
  Shape memory alloy . . .

(c) Metallurgy and Metallography

Phase diagram
  Iron carbon phase diagram . . .
Crystal structure
  Superlattice structure . . .
Metallurgical constituent
  Laves phase . . .
*Physical chemistry
  Thermochemistry
  Steelmaking reaction . . .
Ladle metallurgy
  Deoxidation . . .
Solidification
  Rapid solidification . . .
Plastic deformation
  Hot deformation . . .
Crystal plasticity
  Twinning . . .
Lattice defect
  Dislocation . . .
Grain size
  Grain refinement . . .
Grain boundary
  Subgrain boundary . . .
Interface
  Interphase boundary . . .
Fracture
  Brittle fracture . . .
Segregation
  Grain boundary segregation . . .
Diffusion
  Diffusion coefficient . . .
Solid solution
  Solubility product . . .
Precipitation
  Carbide precipitation
Inclusion
  Oxide inclusion . . .
Recrystallization
  Secondary recrystallization . . .
Phase transformation
  Martensitic transformation . . .
Texture
  Deformation texture . . .
Corrosion
  Fretting corrosion . . .
Oxidation
  Internal oxidation . . .
Metallography
  Quantitative metallography . . .
Microscopy
  Electron microscopy . . .

(d) Property and Service Characteristics

*Physical property
  Elasticity
  Magnetic property . . .
*Chemical property
  Chemical potential
  Heat of formation . . .
*Strength
  Tensile strength
  Work hardening . . .
Toughness
  Notch toughness . . .
Ductility
  Bendability . . .
Formability
  Stretchability . . .
Weldability
  Weld defects . . .
Hardenability
  Quench hardenability . . .
Machinability
  Free cutting . . .
Fatigue
  Low cycle fatigue . . .
Wear
  Abrasive wear . . .
Creep
  Transient creep . . .
Corrosion resistance
  Stress corrosion resistance . . .

(e) Instrumentation, Testing, and Management

Automation
  Robotics . . .
Measurement
  Heat measurement . . .
Sensor
  Magnetic sensor . . .
Process control
  Dynamic control . . .
Production control
  Productivity . . .
Quality control
  Quality assurance . . .
Computer
  Computer programming . . .
Modeling
  Mathematical modeling . . .
Simulation
  Numerical simulation . . .
Economy
  Cost reduction . . .
Energy
  Energy conservation . . .
Utilities
  Power supply . . .
Maintenance
  Repairing . . .
Environmental control
  Pollution control . . .
Lubrication
  Boundary lubrication . . .
Mechanical testing
  Tensile testing
  Hardness testing
Chemical analysis
  Spectrophotometry . . .
*Instrumental analysis
  X-ray diffraction
  Auger spectroscopy . . .
Nondestructive inspection
  Ultrasonic inspection . . .

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SI Units

Base units

Quantity	Unit	Symbol
length	metre	m
mass	kilogram	kg
time	second	s
electric current	ampere	A
thermodynamic temperature	kelvin	K
amount of substance	mole	mol
luminous intensity	candela	cd

Supplementary

Quantity	Unit	Symbol
plane angle	radian	rad
solid angle	steradian	sr

SI prefixes

Multiplication factor	Prefix	Symbol
$1\,000\,000\,000\,000\,000\,000 = 10^{18}$	exa	E
$1\,000\,000\,000\,000\,000 = 10^{15}$	peta	P
$1\,000\,000\,000\,000 = 10^{12}$	tera	T
$1\,000\,000\,000 = 10^{9}$	giga	G
$1\,000\,000 = 10^{6}$	mega	M
$1\,000 = 10^{3}$	kilo	k
$100 = 10^{2}$	hecto*	h
$10 = 10^{1}$	deka*	da
$0.1 = 10^{-1}$	deci*	d
$0.01 = 10^{-2}$	centi*	c
$0.001 = 10^{-3}$	milli	m
$0.000\,001 = 10^{-6}$	micro	μ
$0.000\,000\,001 = 10^{-9}$	nano	n
$0.000\,000\,000\,001 = 10^{-12}$	pico	p
$0.000\,000\,000\,000\,001 = 10^{-15}$	femto	f
$0.000\,000\,000\,000\,000\,001 = 10^{-18}$	atto	a

* To be avoided where practical.

Derived units

Quantity	Unit	Symbol	Formula
frequency (of a periodic phenomenon)	hertz	Hz	l/s
force	newton	N	$kg \cdot m/s^2$
pressure, stress	pascal	Pa	N/m^2
energy, work quantity of heat	joule	J	N·m
power, radiant flux	watt	W	J/s
quantity of electricity, electric charge	coulomb	C	A·s
electric potential, potential difference, electromotive force	volt	V	W/A
electric capacitance	farad	F	C/V
electric resistance	ohm	Ω	V/A
electric conductance	siemens	S	A/V
magnetic flux	weber	Wb	V·s
magnetic flux density	tesla	T	Wb/m^2
inductance	henry	H	Wb/A
Celsius temperature	degree Celsius	°C	K
luminous flux	lumen	lm	cd·sr
illuminance	lux	lx	lm/m^2
activity (of a radionuclide)	becquerel	Bq	l/s
absorbed dose	gray	Gy	J/kg
dose equivalent	sievert	Sv	J/kg

Units in use with SI

Quantity	Unit	Symbol	Definition
time	minute	min	1 min = 60 s
	hour	h	1 h = 60 min = 3 600 s
	day	d	1 d = 24 h = 86 400 s
plane angle	degree	°	$1° = (\pi/180)$ rad
	minute	′	$1′ = (\pi/10\,800)$ rad
	second	″	$1″ = (\pi/648\,000)$ rad
volume	litre	L	$1\,L = 1\,dm^3 = 10^{-3}\,m^3$
mass	metric ton	t	$1\,t = 10^3$ kg

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