MPIF STANDARD 35-SP
2016 Edition

*Materials Standards for*

# PM Structural Parts

*Published by Metal Powder Industries Federation*

MPIF Standard 35

# Materials Standards for PM Structural Parts*

*See MPIF Standard 35, *Materials Standards for PM Self-Lubricating Bearings* for bearings and bushings made by the PM process.

*See MPIF Standard 35, *Materials Standards for P/F Steel Parts* for steel components made by the powder forging (PF) process.

*See MPIF Standard 35, *Materials Standards for Metal Injection Molded Parts* for PM components made by the metal injection molding (MIM) process.

## Table of Contents - 2016 Edition


**EXPLANATORY NOTES AND DEFINITIONS**
Minimum Value Concept ..... 3
Minimum Value ..... 3
What "Minimum Value" Means When Specifying a PM Material ..... 3
Typical Values ..... 4
Chemical Composition ..... 4
Mechanical Properties ..... 4
Heat Treatment ..... 4
Sinter Hardening ..... 4
Surface Finish ..... 4
Microstructure ..... 5
PM Material Code Designation ..... 5
Prefix Letter Code ..... 6
Prefix and Numeric Code ..... 6
Examples of PM Designation Coding ..... 7
Suffix Digit Code ..... 7
Suffix Letter Code ..... 7
Grade Selection ..... 7
Proof Testing ..... 8
Chemical Analysis ..... 8
Density ..... 8
Transverse Rupture Strength ..... 8
Impact Energy ..... 8
Ultimate Tensile Strength ..... 8
Yield Strength ..... 8
Elongation ..... 8
Compressive Yield Strength ..... 8
Shear Strength ..... 9
Macroindentation Hardness (Apparent) ..... 9
Microindentation Hardness (Converted) ..... 9
Fatigue Limit and Fatigue Strength ..... 9
Elastic Constants ..... 9
Young's Modulus (E) ..... 9
Shear Modulus (G) ..... 9
Poisson's Ratio ($\nu$) ..... 9
Soft-Magnetic Alloys ..... 9
Engineering Information ..... 10
SI Units ..... 10
Referenced MPIF Standards ..... 10
Comparable Standards ..... 11
Obsolete Suffix Codes for Density ..... 11

**DATA TABLES - INCH-POUND UNITS**

Iron and Carbon Steel ..... 12–13
Iron-Copper and Copper Steel ..... 14–15
Iron-Nickel and Nickel Steel ..... 16–17
Prealloyed Steel ..... 18–19
Hybrid Low-Alloy Steel ..... 20–23
Sinter-Hardened Steel ..... 24–25
Diffusion-Alloyed Steel ..... 26–29
Copper-Infiltrated Iron and Steel ..... 30–31
Stainless Steel
300 Series Alloy ..... 32–33
400 Series Alloy ..... 34–35
Copper and Copper Alloys ..... 36–37
Soft-Magnetic Alloys ..... 38–39
Aluminum Alloys ..... 40–41

**DATA TABLES - SI UNITS**

Iron and Carbon ..... 42–43
Iron-Copper and Copper Steel ..... 44–45
Iron-Nickel and Nickel Steel ..... 46–47
Prealloyed Steel ..... 48–49
Hybrid Low-Alloy Steel ..... 50–53
Sinter-Hardened Steel ..... 54–55
Diffusion-Alloyed Steel ..... 56–59
Copper-Infiltrated Iron and Steel ..... 60–61
Stainless Steel
300 Series Alloy ..... 62–63
400 Series Alloy ..... 64–65
Copper and Copper Alloys ..... 66–67
Soft-Magnetic Alloys ..... 68–69
Aluminum Alloys ..... 70–71

**ENGINEERING INFORMATION**

Introduction ..... 72
Hardenability ..... 73
Guidelines for Machinability ..... 76
Axial Fatigue ..... 81
Rolling Contact Fatigue (RCF) ..... 82
Strain-Controlled Fatigue ..... 83
Coefficient of Thermal Expansion (CTE) ..... 86
Fracture Toughness ..... 86
Corrosion Resistance ..... 87
Steam Oxidation of Ferrous PM Materials ..... 89
Guidelines for Specifying a PM Part ..... 92

**INDEX**

Alphabetical Listing & Guide to Material Systems & Designation Codes Used in MPIF Standard 35 ..... 94

**SI UNITS CONVERSION TABLE**

Quantities/Terms Used in MPIF Standards..... 99

# Materials Standards for PM Structural Parts

Adopted 1961
Revised: 1965, 1969, 1972, 1974, 1976, 1984, 1987, 1990, 1994, 1997, 2000, 2003, 2007, 2009, 2012, and 2016

## Scope

*MPIF Standard 35 is issued to provide the design and materials engineer with the information necessary for specifying powder metallurgy (PM) materials that have been developed by the PM parts manufacturing industry. This section of Standard 35 deals with conventional PM materials for structural parts. It does not apply to materials for PM self-lubricating bearings, powder forged (PF) or metal injection molded (MIM) products which are covered in separate editions of MPIF Standard 35. The same materials may appear in more than one section of the standard depending upon their common use, e.g., some structural materials may also be used in bearing applications and vice versa. Each section of this standard is divided into subsections based on the various types of PM materials in common commercial use within that section. Notes at the beginning of each subsection discuss the characteristics of that material. Users of this standard should make a determination as to the availability of any referenced material.*

*The use of any MPIF Standard is entirely voluntary. MPIF Standards are issued and adopted in the public interest. They are designed to eliminate misunderstandings between the manufacturer and the purchaser and to assist the purchaser in selecting and obtaining the proper material for a particular product. Existence of MPIF Standards does not in any respect preclude any member or non-member of MPIF from manufacturing or selling products that use materials or testing procedures not included in MPIF Standards. Other such materials may be commercially available.*

*By publication of these Standards, no position is taken with respect to the validity of any patent rights nor does MPIF undertake to ensure anyone utilizing the Standards against liability for infringement of any Letters Patent or accept any such liability.*

*Neither MPIF nor any of its members assumes or accepts any liability resulting from use or non-use of any MPIF Standard. In addition, MPIF does not accept any liability or responsibility for the compliance of any product with any standard, the achievement of any minimum or typical values by any supplier, or for the results of any testing or other procedure undertaken in accordance with any Standard.*

*MPIF Standards are subject to periodic review and may be revised. Users are cautioned to refer to the latest edition. New, approved materials and property data may be posted periodically on the MPIF website. Between published editions, go to mpif.org to access data that will appear in the next printed edition of this standard.*

***Both the purchaser and the manufacturer should, in order to avoid possible misconceptions or misunderstandings, agree on the following conditions prior to the manufacture of a PM part: minimum strength value, grade selection, chemical composition and alloying method, proof testing, typical property values and processes, that may affect the part application.***

No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording or otherwise, without the prior permission of the publisher.

® Copyright 2016
ISBN No. 978-1-943694-04-4

Published by
Metal Powder Industries Federation
105 College Road East
Princeton, New Jersey 08540-6692 U.S.A.
Tel: (609) 452-7700
Fax: (609) 987-8523
E-mail: info@mpif.org
Website: mpif.org

No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording or otherwise, without the prior written permission of the publisher

ISBN No. 978-1-943694-04-4

© 2016 Metal Powder Industries Federation
105 College Road East
Princeton, New Jersey 08540-6692 USA

*All rights reserved*
*Produced in the U.S.A.*