

Tenmat is a leading manufacturer of specialised, high performance, non metallic engineering materials and components, supplied to a broad cross section of industrial applications throughout the world. Tenmat has its headquarters in Trafford Park, Manchester with a machining centre at Cradley Heath in the U.K., France, Germany, Italy and the USA. For many years Tenmat has been committed to excellent technical products used in applications as diverse as furnace insulation and critical components for aerospace. This has demanded a heavy investment in ongoing research and development to both extend the performance characteristics of existing product ranges and take the company forward into totally new and exciting growth areas such as advanced ceramics and composites.

Tenmat activities are divided into 4 main areas:

**ENGINEERING CERAMICS**

The product range includes REFEL silicon carbide and NITRASIL silicon nitride. These advanced materials are backed by substantial manufacturing and machining capabilities and a research and development team with a wide range of facilities.

**WEARING & BEARING COMPOSITES**

Sliding, wearing and bearing applications are major business areas for Tenmat, where its engineering materials FEROFORM, FERONGLIDE & FIBERGLIDE are world leaders in their fields offering design engineers unique and flexible solutions to many problems.

**HIGH TEMPERATURE COMPOSITES**

Where high temperature or heat transference are a problem or where long term insulation at temperature is required then SINDANYO, FIREFLY REFRACTORY PRODUCTS & FILTERS, ARCLEX & REFRAVER have proven to provide outstanding service over many years.

**FIRE PROTECTION & MILLBOARDS**

FIREFLY Intumescent Products are exceptional performers and are increasingly accepted in demanding Fire protection applications. FIREFLY Millboards are used in a wide variety of industrial applications for high temperature thermal insulation and exceptional wear resistance.

**WEARING & BEARING COMPOSITES - ADVANTAGES**

**Excellent Wear Resistance**

FEROFORM materials show consistently lower wear rates than all competitive materials in their field

**Good Dimensional Stability**

Particularly when immersed in water, mineral oils or greases.

**Excellent Abrasion Resistance**

Can be used where abrasive particles are present.

**Low Coefficient of Friction**

Enabling higher speeds and heavier loads to be used, minimizing stick-slip and minimizing power usage

**Self Lubricating**

Can be used without lubrication in many applications.

**Excellent Resilience**

Capable of absorbing high shock loads/impacts and tolerating misalignment without damage

**User Friendly**

Easy to fit (press, draw bar, dry ice & liquid nitrogen). FEROFORM is machineable in situ

**Electrical Insulation**

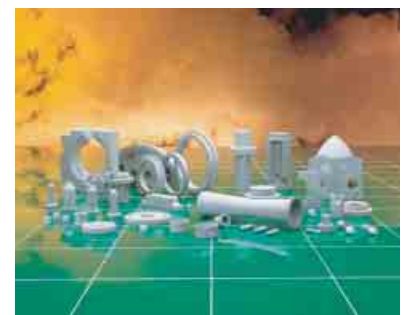
FEROFORM does not promote electrolytic corrosion (non graphited grades)

**Good Chemical Resistance**

Good performance with most mineral & organic acids, solvents, organic bases & non-caustic alkalis.

**Wide Temperature Range**

Can operate in applications from -40°C to +280°C.





FEROFORM™ T grades were developed to offer the highest performance in all marine applications. All types of vessels from water taxis to supertankers have provided years of reliable service fitted with FEROFORM™ rudder and stern tube bearings in all sea conditions from shallow coastal water to deep seas, from the Arctic to the Arabian Gulf.

### BENEFITS

- **Self lubrication**  
FEROFORM™ T Grades are frequently used dry, exploiting their self lubricating ability.
- **Excellent dry and wet**  
Performance free from electrolytic corrosion.
- **Superior Wear Resistance**  
Supreme in all applications saving operation downtime.
- **Superb Abrasion Resistance**  
In all water conditions.
- **Low Friction Coefficient**  
Enables higher speeds to be used and heavier payloads to be carried. Minimises stick slip and produces quiet, cool running bearings with lowest power useage.

- **Easy Installation**  
Can be installed by press, draw bar or freeze (dry ice or liquid nitrogen). Light weight (circa 20% that of bronze) eases handling problems.

### APPLICATIONS

- **Rudder bearings**  
High Pressure approval to 10MPa with all the major classification societies to the latest test regimes.
- **Stern Tube bearings**  
For both military and commercial use. Fully approved.
- **Deck Equipment**  
Self lubricating bearings running dry and wet in hatchcovers, anchor windlasses, fairleads, cargo & bow doors, davits etc.
- **Slipway Liner Pads**  
R.N.L.I. specified maintenance free, long life.
- **Bearings**  
Stern roller, steering linkage, steerable propulsion pivots etc.



Slipway pads



Stave Bearings



Stern tube bearings HMS Birmingham Type 42 Frigate



# Property Data

TENMAT

Properties	Units	T14	T11	T12	T814	F21	F363	F57	C13	F61
Compressive Strength	MPa	310	290	285	305	195	318	380	210	315
	PSI	44950	42050	41325	44225	28275	46110	55100	30450	45675
Normal Working Strength	MPa	75	75	75	75	48	80	85	52	80
	PSI	10875	10875	10875	10875	6960	11600	12325	7540	11600
Compressive Yield	%	2.5	2.4	2.5	3	1.9	1.5	1.5	1.35	2.2
Tensile Strength	MPa	80	80	80	100	57	97	110	63	180
	PSI	11600	11600	11600	14500	8265	14065	15950	9135	26100
Shear Strength	MPa	75	75	75	80	53	96	125	72	99
	PSI	10875	10875	10875	11600	7685	13920	18130	10440	14355
Flexural Strength	MPa	n/a	n/a	n/a	n/a	88	143	150	93	129
	PSI					12760	20735	21750	10440	18710
Impact Strength	KJ/m <sup>2</sup>	55	65	75	89	8	59	50	13	84
Density	g/cm <sup>3</sup>	1.32	1.32	1.32	1.3	1.35	1.5	1.22	1.85	1.7
Brinell Hardness	HB	25	23	23	21	30	36	35	34	30
Water Swell	20°C	0.2	0.3	0.3	0.3	1.1	0.7	0.5	0.6	n/a
	80°C	1	1	2	1	3.1	1.8	0.8	0.65	
Friction	μ	0.13-0.18	0.09-0.12	0.08-0.16	0.04-0.08	0.12-0.25	0.13-0.15	0.12-0.16	n/a	n/a
Thermal Expansion	x10 <sup>-6</sup> /°C	⊥	70	70	70	70	118	40	50	50
		=	35	35	30	30	22	16	12	17
Normal Maximum Temperature	°C	100	100	100	100	130	200	200	175	300
	°F	180	180	180	180	266	390	390	350	570
Intermittent Maximum Temperature	°C	120	120	120	120	150	280	250	200	350
	°F	250	250	250	250	300	535	480	390	660

n/a not possible to produce results (T grades too flexible, F61 resin is not compatible with water, C13 & F61 not bearing grades)

All grades compatible with oil, grease & water lubrication except F61.

Ultimate compressive strength of tube wrapped grades are typically:- T814 250MPa, T14 250MPa, T11 185 MPa, T12 260MPa

Friction values of 0.01 (with water) and 0.016 (with oil) have been recorded in hydrodynamic conditions (shaft speed over 40m/min typically).

Tests above have been conducted generally in accordance with BS2782 and ASTM test methods. The values above are typical test results on sheet materials and should not be taken as guaranteed, for specifications or primary selection of materials. The information herein is presented in good faith but TENMAT does not warrant the conformity of its materials to the listed properties or the suitability of its materials for any particular purpose. In the event of any doubt about the suitability for any application please contact our technical staff on Tel:+44 (0) 161 872 2181, Fax: +44 (0) 161 872 7596, e mail: info@tenmat.com

## Availability

FEROFORM can be supplied in tube, sheet, rod and as fully machined components to customer requirements.

Tube 20 - 200mm(3/4" - 7.7/8")ID & 30 - 250MM (1.3/16" - 10")OD minimum wall thickness 5mm (3/16") Tolerance +0/-1mm (+0/- 0.04")ID Minimum wall thickness 10mm (3/8") up to 400mm (15.3/4") OD and 20mm (3/4") thereafter up to 1500mm (59") OD. Tolerance +0/-2mm (+0/-0.08") ID All OD is supplied +/-1% of nominal OD

Rod 19 - 111mm (3/4" - 4.3/8") OD x 1220mm (48") long tolerance +0/-1mm 117 - 158mm (4.5/8" - 6.1/4") OD x 305mm (12") long tolerance +0/-1mm

Sheet 1.6 - 100mm (1/16" - 4") thickness 1220 x 1220mm (48" x 48") thickness tolerance unsanded 1.25 - 10mm (0.05" - 0.375"), sanded +/-0.1mm (+/-0.004") length & width +0/+3mm (-0/+1/8") Larger sizes and special mouldings available on request

## Treatments

For applications above 70% of the maximum temperature we recommend that FEROFORM is heat stabilised prior to machining to maintain their required dimensions. Heat treatment is denoted by suffix 7 e.g. T127 Oil impregnation (suffix 1) can reduce friction and aid bedding inMoS2 (suffix 8) treatment can be used instead of oil for dusty environments Special TENMAT bedding in paste is recommended especially for T814 to reduce initial friction and minimise wear.





**TENMAT**

## GRADES

The principal grades of FEROFORM are:-

### T14

A cured phenolic resin matrix reinforced with a woven synthetic fibre cloth. A general purpose grade especially developed for water lubricated applications

### T11

As T14 but with graphite evenly dispersed throughout the matrix for improved wear and lower friction. A general purpose grade.

### T12

As T14 but with molybdenum disulphide evenly dispersed throughout the matrix for improved wear and lower friction. Does not promote electrolytic corrosion.

### T814

As T14 but with PTFE (Teflon) evenly dispersed throughout the matrix for improved wear and lower friction. Especially developed for hydro power applications. Has superb performance.

### F57

A cured phenolic resin matrix reinforced with a specially engineered woven aramid fibre cloth. Low friction, superb wear and abrasion resistance properties.

### F363

A cured phenolic resin matrix reinforced with a woven glass/aramid fibre cloth with graphite evenly dispersed throughout the matrix. A high temperature resistant general purpose grade.

### F21

A cured phenolic resin matrix reinforced with a woven organic fibre cloth with graphite evenly dispersed throughout the matrix. A general purpose grade especially for railways.

### C13

A cured phenolic resin matrix reinforced with glass fibre mat with inert filler evenly dispersed throughout the matrix. A high temperature resistant general purpose grade. Designed for press platten insulation

### F61

A cured silicone resin matrix reinforced with a woven glass fibre cloth. An extra high temperature resistant general purpose grade particularly for aerospace applications.

Other grades are available. Specific data sheets are available on all grades.

## MACHINING SERVICE

In addition to supplying FEROFORM in the form of rods, tubes, sheets and mouldings etc Tenmat also offers a complete machining service for the supply of fully finished components. Stringent quality control is exercised at all stages of manufacture and approvals have been granted by many Government departments, public utilities, major manufacturers and users.

Materials which have been machined by Tenmat are supplied packaged to keep them free from contamination (particularly important with oil impregnated grades) during shipping and storage. The products should be stored in dry, covered conditions and if taken out of their packaging, should be kept in sealed polythene bags until they are required for use.

Customers wishing to machine Tenmat materials themselves should consult the Health & Safety section.

## HEALTH & SAFETY

If recommended working practices are followed, any risk to health will be minimal. In the U.K., machining operations such as cutting, sawing, milling, sanding, drilling etc or finishing operations (filing, scraping etc) are liable to give rise to dust, the inhalation of which (as with any dust) should be avoided and require a disciplined approach in handling, machining and storage.

In general, any machining operation on FEROFORM materials is similar to an equivalent operation on cast iron and if in doubt the technique for machining cast iron can be followed. It is normal practice to machine FEROFORM dry with dust extraction at the cutting point, either by means of a fully ducted dust extraction system or cleaner which conforms to BS 5415 class H. Protective clothing should be provided for workers when a significant quantity of dust is liable to be deposited on their clothes. After use, protective clothing should be sealed in a dust tight bag for laundering either on-site or by a suitable specialist organisation. Where the amount of fibre produced by an operation is likely to exceed the HSE Control Limit personnel working in the affected area MUST wear approved types of clothing and respiratory protective equipment (masks). Product data sheets providing comprehensive Health & Safety recommendations on individual products are available, together with information on supplies of approved respirators and protective clothing - please contact Tenmat.

## DESIGN SERVICE

Tenmat offers a full bearing design service and can offer assistance where required with installation.

## QUALITY ASSURANCE

In recognition of Tenmats' internal Quality Systems for FEROFORM approvals have been granted by the following:

British Standards Institute

Assessed to BS EN ISO 9002:1994

Ministry of Defence

Suppliers to Ministry of Defence Approved Contractors under BS EN ISO 9002:1994 Registration

Marine Society Approvals

Lloyds Register

American Bureau of Shipping

Bureau Veritas

Det Norske Veritas

Germanischer Lloyd

Korea Register

China Classification Society

and many others

## SUPPLY

FEROFORM materials are available in the U.K., Germany, France, Italy & USA/Canada from Tenmat. In other countries they can be obtained through a worldwide network of distributors. Please contact Tenmat U.K. for details.