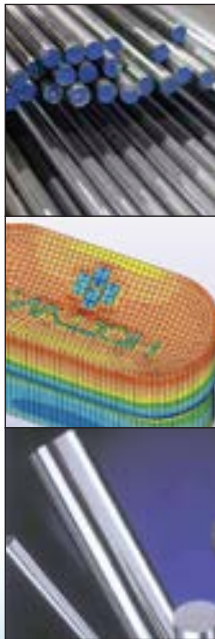


PharmaGrade®

*Durability,
Productivity,
Longevity.*





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Introduction

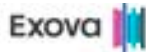
As one of the worlds leading tablet tooling manufacturers I Holland has been instrumental in introducing many innovative and unique developments to the industry. I Holland continues to invest and drive the company forward through a commitment to research and development and problem solving initiatives.

Understanding materials science has always been of utmost importance to I Holland. We believe that a fundamental part of delivering first class customer service is an in-depth knowledge of the materials we use. This has led to the introduction of a continuous component testing programme and the MCP (Metal Conditioning Project). This project has led to advancement in I Holland's understanding of steel metallurgy allowing the company to further improve the properties of our Holland PharmaGrade® steel types differentiating these from alternative materials used for tablet tooling. MCP has been led at the highest level by the Managing Director with input from the Research & Development and Manufacturing departments while also including Supervisors from key areas of manufacture on the factory floor. Our work has been supported by a number of research and academic partners including:

Wolfson Heat treatment Centre



Exova



University of Nottingham



Non-Destructive Testing Services



I Holland's PharmaGrade® range of steels achieve an optimum balance of the following characteristics recognising that the selection of the right steel is key to the successful performance of tablet compression tooling:

Strength: Ability to withstand an applied stress without failure.

Fatigue resistance : Progressive and localised structural damage that occurs when a material is subject to cyclic loading.

Toughness: Resistance to chipping, cracking & punch tip breakage.

Abrasive wear resistance: Resistance to abrasive wear of punch tips and die bores.

Adhesive wear resistance: Resistance to adhesive wear, galling & welding.

Hardness: Resistance to impregnation from hard, sharp granules.

Compressive strength: Resistance to die bore ringing and plastic deformation of punch tip edges.

Corrosion resistance: Resistance to oxidising, staining and discolouration.

I Holland's customer service group can provide guidance on all aspects of material selection.



Steels: An overview

There are thousands of steel types available but only a few meet the complex design and functional requirements of tablet tooling. Chemical composition of the steel is only one part of the overall equation, material selection must always be considered alongside good tablet design for strong punch cups and punch tip edges.

To optimise the material and its properties, other processes are required such as:

- **Steel refinement (ESR - Electro slag re-melting)**
- **Optimal heat treatment**
- **Treatments and coatings**
- **Powder Metallurgy**

All PharmaGrade materials are highly refined to our own specifications and this quality is provided at no additional cost to our customers giving increased strength and wear resistance to tablet tooling.

Steel Refinement - ESR

Holland's PharmaGrade ESR material (HPG-S & HPG-P) has a homogeneous carbide structure which is distributed evenly throughout the steel. This provides benefits for the end user such as increased tool strength, extended tooling life over conventional (non-refined) steel and coating uniformity.

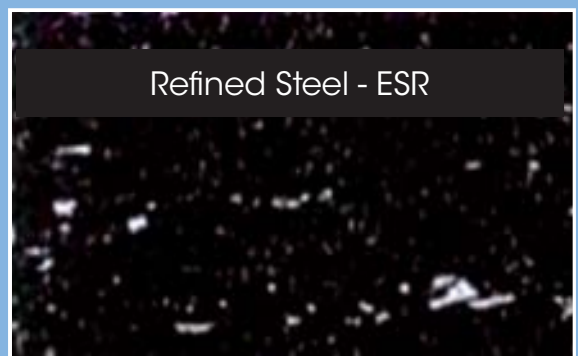
Powder Metallurgy

Holland offers two specialist powder metallurgy steels (HPG-MP & HPG-MD) each offering a uniform carbide distribution, small carbide size and extremely high wear resistance when compared to HPG-S and HPG-P. Powder Metallurgy steels are recommended for extremely abrasive products.

Cross Sections Showing Carbide Distribution



Conventional Steel



Holland PharmaGrade®
HPG-S & HPG-P



Holland PharmaGrade® Steels
HPG-MP & HPG-MD



PharmaGrade® Steels





HPG-S (Holland PharmaGrade® Standard)

Description

HPG-S has recently been improved through I Holland's ongoing R&D programme. A high quality ESR grade punch material suitable for general purpose applications typically used in more than 60 percent of cases. Superior quality to other 'standard' steels.

Features

Harder and more wear resistant compared to equivalent steels used for tablet tooling (see table on page 13)
Very high toughness properties
High strength profile
Good polish-ability (due to ESR process)
Optimised for PharmaCote® products (see table on page 13)

Benefits

Long tooling life
Resistant to fracture
Reduced tableting problems

Application

For standard application on punches especially deep cupped tips and complex shapes





HPG-P (Holland PharmaGrade® Premium)

Description

HPG-P has also been improved through I Holland's ongoing R&D programme. A high quality ESR grade punch and die material suitable for formulations that are particularly abrasive. Superior quality to other 'premium' steels. (see table on page 13)

Features

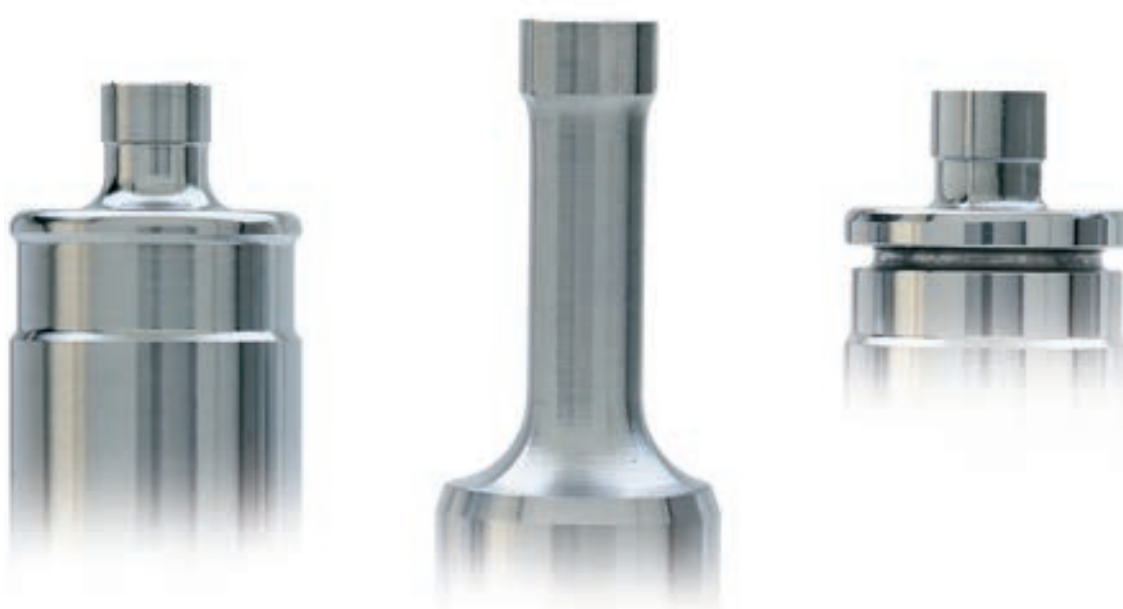
Higher wear resistance compared to HPG-S
High compressive strength for improved die performance
Good polish-ability (due to ESR process)
Optimised for PharmaCote® products (see table on page 13)
Higher chrome content than HPG-S

Benefits

Long tooling life
Resistant to fracture and die bore ringing
Reduced tableting problems
Improved corrosion resistance over HPG-S

Application

For standard application on dies and punches requiring improved wear resistance





HPG-SS (Holland PharmaGrade® Stainless Steel)

Description	HPG-SS is a martensitic fine carbide structured stainless steel, a tried and tested solution used for punches and dies where corrosion resistance is a primary requirement.
Features	Excellent corrosion resistant properties Good polish-ability (due to fine carbide structure) Optimised for PharmaCote® products (see table on page 13) Higher chrome content than HPG-S and HPG-P
Benefits	Extended tooling life when compressing corrosive formulations
Application	For punches and dies to be used with corrosive formulations, wash in place systems (WIP) and other aggressive cleaning processes.





HPG-MP (Holland PharmaGrade® Powder Metallurgy Punches)

Description A specialist powder metallurgy grade steel with uniform carbide distribution and small carbide size giving extremely high wear resistance over and above that of Premium steel. Used for punches only.

Features Very high wear resistance
High fatigue resistance
Good polish-ability (due to uniform carbide distribution)

Benefits Extended product life over HPG-P due to enhanced wear resistance
Resistant to fracture
Reduced tableting problems (i.e. sticking etc)
Has been proven to increase product life by up to 115% over HPG-P

Application A specialist solution for punches when compressing highly abrasive compounds





HPG-MD (Holland PhamaGrade® Powder Metallurgy Dies)

Description

A specialist powder metallurgy grade steel with uniform carbide distribution and small carbide size giving extremely high wear resistance over and above that of HPG-P. Used for dies only.

Features

High wear resistance
Extremely high compressive strength
Reduced risk of formulation reacting to elements within the die material (unlike Tungsten Carbide)

Benefits

Reduces die bore wear compared to HPG-P
Reduced die bore ringing compared to HPG-P
No black marks on tablets

Application

A specialist solution for dies used to eliminate black marks caused by tungsten carbide for highly abrasive products





HPG-TC (Holland PharmaGrade® Tungsten Carbide)

Description	A sintered micro grained tungsten carbide cemented with cobalt
Features	High compressive strength Extremely high wear resistance Inert
Benefits	Reduced die bore wear compared to HPG-P Reduced die bore ringing compared to HPG-P Will last longer than HPG-MD when compressing abrasive formulation
Application	Used to improve wear resistance of die bores when compressing abrasive product

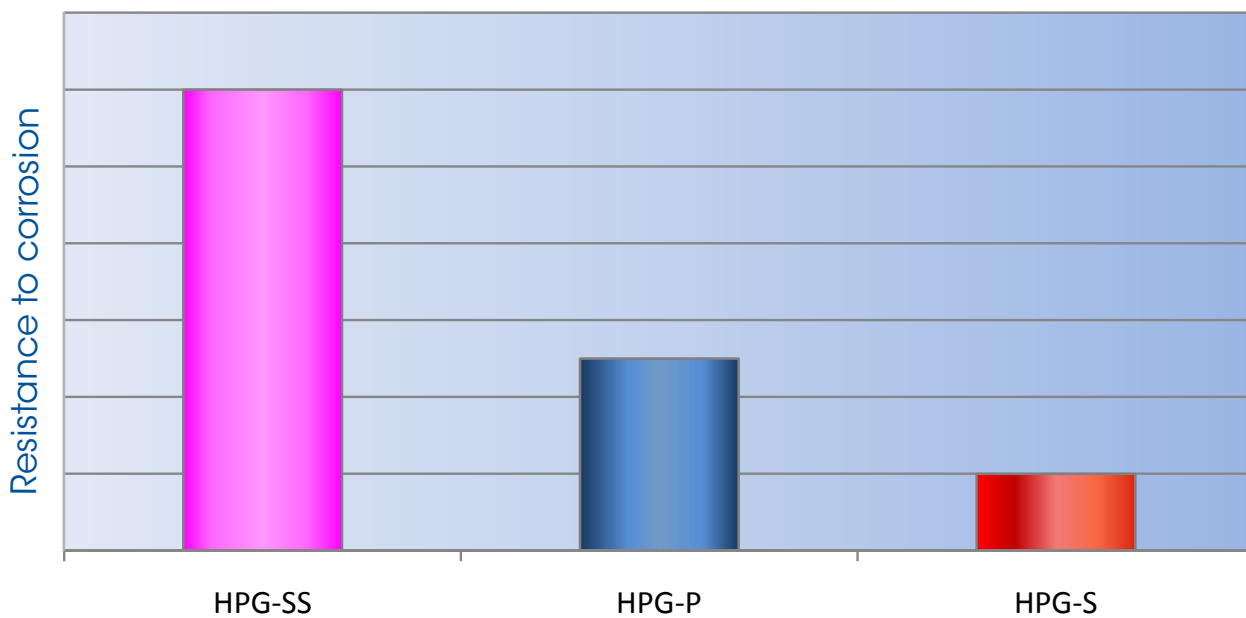


Reference tables

Anti-fracture / Wear Resistance Guide






Corrosion Resistance Guide



Note: Data based on chrome content

Treatments and Coatings

Holland's PharmaCote® range is a suite of treatments and coatings that enhance the performance of substrate material for punches and dies. Our PharmaCote® range is focused on:-

-  Improving wear resistance
-  Improving corrosion resistance
-  Improving anti-stick properties



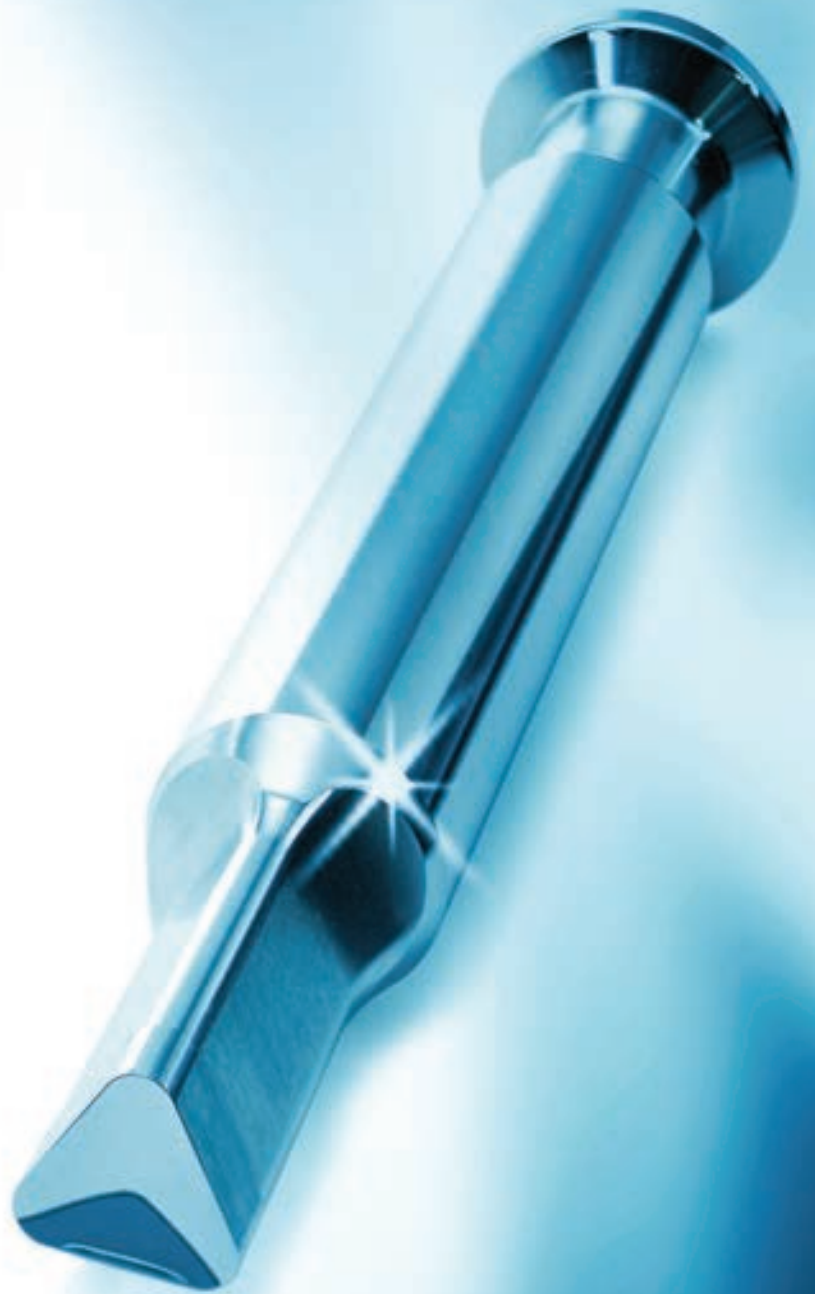
Our PharmaCote® brochure is also available to advise on this range of treatments and coatings.

COATING	Tooling Type		Steel Type		
	PUNCHES	DIES	HPG-S	HPG-P	HPG-SS
PharmaCote® HC (Standard)	✓	✓	✓	✓	✓
PharmaCote® HC (Barrel & Tip)	✓		✓	✓	✓
PharmaCote® HC (All Over)	✓	✓	✓	✓	✓
PharmaCote® HC (Tip Only)	✓		✓	✓	✓
PharmaCote® HC (Head, Neck & Barrel)	✓		✓	✓	✓
PharmaCote® HC+ (Standard)	✓		✓	✓	✓
PharmaCote® HC+ (Barrel & Tip)	✓		✓	✓	✓
PharmaCote® HC+ (All Over)	✓		✓	✓	✓
PharmaCote® HC+ (Tip Only)	✓		✓	✓	✓
PharmaCote® EC (Standard)	✓		✓		
PharmaCote® CN (Standard)	✓	✓		✓	✓
PharmaCote® CN (Barrel & Tip)	✓			✓	✓
PharmaCote® CN+ (Standard)	✓			✓	✓
PharmaCote® CN+ (Barrel & Tip)	✓			✓	✓
PharmaCote® CX (Standard)	✓			✓	✓
PharmaCote® CX (Barrel & Tip)	✓			✓	✓
PharmaCote® CX+ (Standard)	✓			✓	✓
PharmaCote® CX+ (Barrel & Tip)	✓			✓	✓
PharmaCote® TN (Standard)	✓	✓		✓	✓
PharmaCote® TN (Barrel & Tip)	✓			✓	✓
PharmaCote® DN (Tip Only)	✓		✓	✓	✓
PharmaCote® RS (Tip Only)	✓			✓	✓



This brochure details treatments & coatings that are currently available for I Holland tooling. The Research and Development Team is constantly working on the development of new treatments and coatings.

For further information on our R&D activity, please contact info@iholland.co.uk.



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TABLETTING SCIENCE

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