outokumpu
high performance stainless steel

2205 Machining Guideline

The aim of this machining guide is to be an introduction to anyone starting to machine 2205. The cutting parameters in this guideline will work under normal cutting conditions. (A guide for further optimization of cutting parameters can be found under trouble shooting in the next page).

Machining duplex stainless steel

A large benefit of Duplex Stainless Steel grades compared to austenitic grades is their high proof stress. The Duplex grades typically have twice the strength compared to austenitics. This will of course affect the machinability, but not as much as one would fear. Some general rules to have in mind when machining Duplex:

- Ensure a stable setup – Higher cutting forces compared to standard austenitic grades
- Use sharp tools in order to generate less heat and minimize work hardening
- Coolant – Less heat results in a longer tool life

Turning

- The machine and setup must be rigid
- Use carbide grade M20-M25 or P20-P25
- Always use coolant
- Use smallest possible nose radius to avoid vibrations

Starting Values – Cutting speed v_c (m/min)

	Feed - f_z (mm/rev)		
	Finishing f_z=0.1	Medium f_z=0.4	Roughing f_z=0.8
Carbide	100	85	55
HSS	22	17	–

Milling

- Use shortest possible tool length
- Avoid cutting through holes/cavities
- Use carbide grade M20-M30 or P20-P35
- Ensure good chip evacuation, recutting of chips may cause tool damage

Starting Values – Cutting speed v_c (m/min)

	Feed - f_z (mm/teeth)		
	Finishing f_z=0.1	Medium f_z=0.25	Roughing f_z=0.5
Carbide	90	80	55
HSS	28	24	–

Drilling

- Always use coolant
- If possible use internal coolant through drill
- Stable setup is very important when drilling through holes

Starting Values – Cutting speed v_c (m/min)

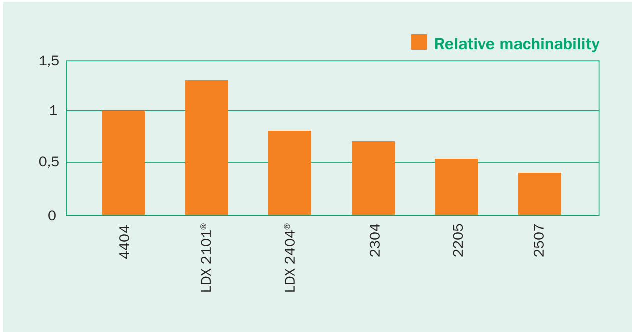
	Type of drill		
	External coolant	Internal coolant	Indexable inserts
Carbide	45	60	85
HSS	20	–	–

Formulae

RPM	Cutting speed	
$n = \frac{v_c \cdot 1000}{\pi \cdot D}$	$v_c = \frac{n \cdot \pi \cdot D}{1000}$	n = RPM (rev/min) v_c = Cutting speed (m/min) D = Tool/workpiece dia (mm)

Machinability ranking

The machinability of different stainless steel grades can be illustrated by a machinability ranking. This ranking, where a higher figure means better machinability, is based on a combination of test data from several different machining operations. The ranking shows that LDX 2101® has excellent machining properties also in relation to 4404 and that the machinability decreases with increasing alloy content.

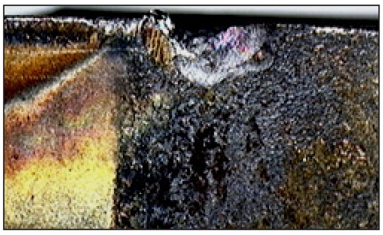


Trouble shooting

Flank wear

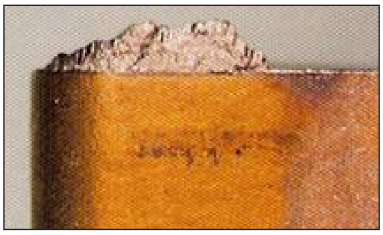
This is the ideal wear mechanism for a good and reliable machining. For longer tool life – *reduce cutting speed.*

Notch

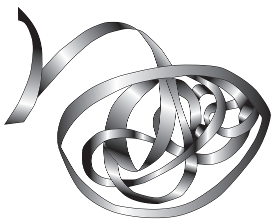


A common wear mechanism when machining in duplex stainless steel. Increased cutting speed will reduce notch but increase flank wear. If possible, use a *variable cutting depth.*

Build up edge



When the cutting speed is too low, the stainless steel tends to stick to the tool (in milling the chips stick to the tool). To avoid – *Increase cutting speed.*



Long chips

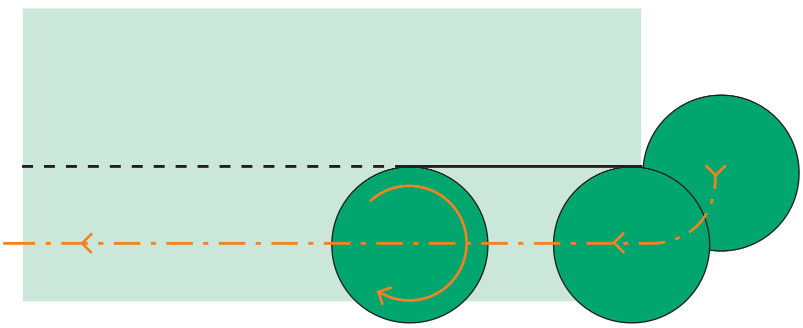
Can lead to tool breakage.
To avoid – *increase feed.*

Plastic deformation

Most common in turning operations.
To avoid – *reduce both cutting speed and feed.*

Milling engage cycle

Entering the work piece can cause tool damage, especially in high alloyed duplex grades. By a soft curved entering, damage can be avoided. When passing through holes or cavities reduce cutting speed and feed (~25%).



Working towards forever.

We work with our customers and partners to create long lasting solutions for the tools of modern life and the world's most critical problems: clean energy, clean water and efficient infrastructure. Because we believe in a world that lasts forever.

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