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The Power of the Coating

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Tool coatings are everywhere. Coatings can be found for all sorts of applications. With all the choices out there, it becomes confusing which ones to choose. How do we know the right coating for our application? When we understand tool coatings, we unlock the potential of our machine tools.

Cold Welding

One of the first considerations when evaluating a tool coating for an application involves avoiding cold welding. Cold welding is the process where like materials under extreme pressure are bonded together. The atoms bond and it becomes a homogeneous mass. But why does cold welding matter for tool coatings? The reason is cutting forces in our machines are extreme. When using a tool coating that is similar or the same as the material we are cutting, the tool will weld to the material. This is why there are recommendations for avoiding certain coatings with certain materials.

Cold welding is the reason diamond-coated inserts are not good for steel.

Diamonds are pure carbon, and they will weld to bond with the carbon in the steel.

What do we need our coating to do? Is it to remove heat? To reduce friction? Do we need it to have edge strengthening properties for interrupted cuts? Does it need to help protect the tool from highly abrasive materials that contain aluminum oxides? There are coatings that offer high performance in multiple categories. All-purpose coatings work well in most general applications; however something like AlTiN is not recommended for use in aluminum alloys because of cold welding.

Heat Is the Enemy

The enemy of our tool coating is heat. Specific types of coatings can take distinct levels of heat before they start to degrade. It is important to know the factors that generate heat in the cutting tool. In physics, friction is where the heat is generated. In machining, we say speed causes heat, not feed. I know people are going to say they both cause heat. Both can, but speed puts heat into the tool whereas feed puts heat into the chip. We all know you can feed so hard you break a tool, but the fracture occurred due to forces flexing the tool, not overheating causing coating and edge failure.

Notes to coatings:

Max Working Temp. The temperature the coating will start to break down. You need to maintain cutting temperatures below this value to preserve the coating. Coolant and speed will play a significant role.

Vickers Hardness. The higher this value the more edge protection your tool will have. A higher value provides protection against abrasive inclusions in material. All data in this article is in Vickers Scale HV 0.05.

Coefficient of Friction. Friction is the enemy of our tool coating. Lower values of coefficient of friction allow us to achieve greater speed without coating wear. A lower value will also reduce flank wear because of less pressure when rubbing.

TiN. Titanium Nitride coating has been around a long time. It is that familiar gold color on tooling we have all seen and is still a solid coating for general purpose applications. It has a max working temperature of around 1,000 degrees F. TiN has a Vickers hardness of approximately 2,300 (varies by manufacturer). TiN has a coefficient of friction about 0.40.

AlTiN. Aluminum Titanium Nitride is a great all-around coating. It is a black to gray shiny coating. It has a max working temperature of around 1,400 degrees degrees F. AlTiN has a Vickers hardness of approximately 3,500 (varies by manufacturer). AlTiN has a coefficient of friction about 0.70.

TiB2. Titanium Diboride is great in non-ferrous materials. It is a dull gray-white coating. It has a max working temperature of around 900 degrees F. TiB2 has a Vickers hardness of approximately 2,800 (varies by manufacturer). TiB2 has a coefficient of friction about 0.35.

DLC. Diamond-like carbon (or amorphous diamond) is great in non-ferrous materials. It is a dull black coating. It has a max working temperature of around 750 degrees F. DLC has a Vickers hardness of approximately 8,200 (varies by manufacturer). DLC has a coefficient of friction about 0.1.

Tool coatings are changing all the time. Companies like PH Horn are producing new coatings and reinventing old ones. Experiment with different companies' coatings within the same families. For instance, one company's AlTiN may be better than another for your current application. Within the standard families of coatings, there are hundreds of proprietary coatings offered. Stay up to date with your technical sales reps to get coatings that will work best in your application. Having a great relationship with your tech rep will go a long way to getting your job done as efficiently as possible. Here's to more chips in the hopper and more parts in the pan!

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