Nano-Dies - Big Diamond Dies that Work Better and Cost Less - Rod, Wire and Tube

There is a new type of Drawing Die which is saving Wire and Tube Manufacturers a huge amount of money and trouble.

It is called a Nano-Die, NCDC Die or Nanocrystalline Diamond Composite Die if you prefer the full wording. Drawing Diameter Range is Ø1.2 mm to Ø17.0 mm for wire and rod – Ø3 mm to Ø50 mm for tube applications.

The cost of these dies is MUCH lower than the equivalent PCD dies. Around 3-6 times lower in fact. But where PCD dies leave off at about Ø30mm max dia, Nano-Dies are just warming up.

Nano-Dies also hold tolerance a bit longer than PCD dies in certain applications.

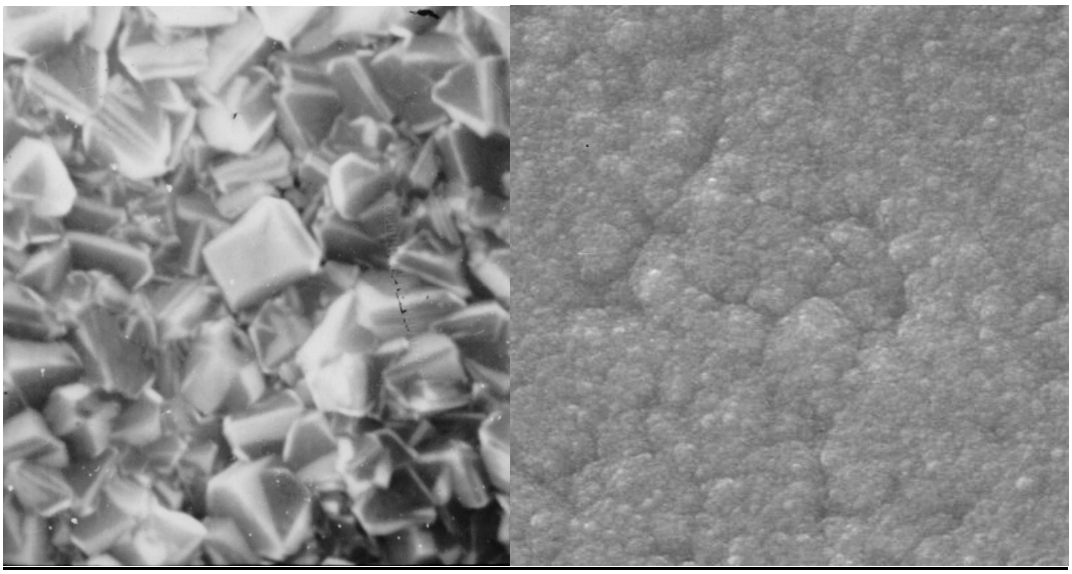
The Single Crystal Structure of Nanocrystalline Diamond Composites is the reason why they may outlast PCD dies. The NCDC manufacturing process results in a die which is 3.5 to 4 times harder than ANY other surface process can achieve.

Summary of Manufacturing Process:

2 or 3 layers of Nanocrystalline Diamond coating are applied to the surface of a completed Tungsten Carbide die in a high vacuum, high temperature process known as CVD. The initial layer has a polycrystalline structure (like fine grain PCD material), but the top layers form a single structured diamond crystalline coating with individual crystals in the nanometre range of sizes. The single crystal structure provides immense strength and hardness, exceeding the hardness of PCD material. The extremely fine crystalline structure also yields superb surface quality and gives rise to the popular name "Nano-Dies".

Contrasting the difference between the surface of a PCD die (left) and a Nano-Die (right)

4,000 x Magnification



Specific Applications:

Regular repeat orders for Nano-Dies are being received for the following applications:

Stainless Steel Wire Drawing (up to ½ Hard)

Low Carbon Steel Wire Drawing

Aluminium and Aluminium Alloy Wire Drawing

Welding Rod Drawing and Finishing

Low Carbon Steel Tube Drawing

Copper, Brass and Aluminium Wire & Tube Drawing, without Float Die (Plug)

Tube Closing Applications (before and after Welding Station)

Further trials are being conducted on many materials. This document will be updated to reflect the current state of the art as the performance comparisons become clear.

Justification:

Improved Surface Finish: The primary justification for specifying Nano-Dies for Wire and Tube Drawing operations may be tooling cost savings, or die life, or superior surface quality of the finished product.

Power Saving: A plant manager has reported significant power savings since switching to Nano-Dies. The surface of the Nano-Dies is much smoother, generating much less friction. Hence less force is required to draw the factory's products and this translates directly into lower energy bills.

Looking at the detailed comparisons:

(a) Compared with Tungsten Carbide Dies: In round figures, Nano-Dies cost roughly 3 to 5 times more than the equivalent Tungsten Carbide dies and they hold tolerance 10-20 times longer than Tungsten Carbide dies in a Drawing processes. The surface finish achievable on the Wire or Tube is also noticeably superior when using Nano-Dies.

(b) In some processes, the fact that Nano-Dies leave the work surface free of lubricant enables a cleaning pass to be eliminated.

(c) Compared with PCD Dies: PCD Dies are available up to Ø29 mm. Nano-Dies are available up to Ø17 mm for Wire Drawing Applications and Ø50 mm for Tube Drawing and Tube Closing Applications. In round figures, Nano-Dies cost around 3 to 6 times less than the same diameter PCD Dies. Nano-Dies also hold tolerance a bit longer than PCD Dies in some applications, due to the additional surface hardness provided by their single crystal structure.

(d) Compared with dies employing other Surface Coatings: The hardness of Nanocrystaline Diamond Composites is 3.5 to 4 times greater than ANY other die coating material.

(e) A recent trial of a Ø6.35mm Nano-Die drawing Stainless Steel Tube ran for 300 km with ZERO WEAR on the die.

(f) A recent trial of a string Nano-Dies replacing PCD dies in an Aluminium Alloy rod breakdown process yielded a highly successful result. The customer reported that all previous difficulties with the procees had vanished "as if by magic". We attribute the success to the low friction of Nano-Dies, combined with a consistently excellent die profile.

Further detailed performance figures and comparisons are given on the Summary Page for Interwire Atlanta April 2011. See http://www.sanxinamerica.com/nano_interwire.html.

Standard Casings:

This subject is important due to the Nano-Die manufacturing process.

Large Casings: Very large casings become very hot during the CVD deposition process. This requires the process to be stopped a number of times while the casings cool down to safe levels, so as not to damage the nanocrystalline diamond coating. Consequently, manufacture of Nano-Dies with very large casings is less efficient than when the casings are of moderate or standard dimensions. A 10% or 15% surcharge is applied when casings are specified which are larger than the limits set out below.

Small Casings: Die Cases smaller than the minimum sizes shown in the table below can be supplied if required, but they are not recommended. Nano-Dies benefit from being strongly mounted in generously sized casings, in order to provide maximum support for the nanocrystalline diamond surface structure. Sanxin cannot accept responsibility for the performance of any Nano-Dies supplied in casings smaller than those recommended in the table below (next page):

Nano-Dies – Table of Standard Casings

Die Bore Dia. Range d (mm)	Std Casing (mm) Dia.	Height	Min. Casing Size (mm) Dia.	Height	Larger Casings (A) 10% Surcharge Dia.	Height	Larger Casings (B) 15% Surcharge Dia.	Height
3<d<10	40 +8/-0	25 +5/-0	40	25	48<D<60	30<H<37.5	60<D<100	37.5<H<62.5
10<d<15	50 +10/-0	30 +6/-0	50	30	60<D<75	36<H<45	75<D<125	45<H<75
15<d<25	60 +12/-0	35 +7/-0	60	35	72<D<90	42<H<52.5	90<D<150	52.5<H<87.5
25<d<30	70 +14/-0	40 +8/-0	70	40	84<D<105	48<H<60	105<D<175	60<H<100
30<d<40	75 +15/-0	40 +8/-0	75	40	90<D<112.5	48<H<60	112.5<D<187.5	60<H<100

Notes on Using Nano-Dies for Wire and Tube Drawing Applications:

1. Make a visual check that the NCDC inside coating is in good condition before use.

2. Place the die in the die holder and run guide wires into the die.

3. Special Attention :

3.1 Avoid using a hammer or other hard object to hit the die whilst loading or unloading the die from its holder. The surface NCDC layer may be damaged by sudden shocks.

3.2 To improve the die life, guide wires should be adequately annealed and all welding burs and ridges should be rounded.

4. Special notes on Drawing Aluminium wire:

4.1 Use moderate Area Reductions to avoid any possibility of Aluminium from the surface of the wire becoming detached and sticking to the working surface of the die.

4.2 If the die is intended for Drawing both Copper and Aluminium wire, best results will be achieved if the die is used on Copper before it is used on Aluminium.

4.3 Aluminium sticking to the working surface of the die may be reduced or eliminated by lubricating with industrial alcohol or transformer oil. It is essential to eliminate this problem if it occurs. If necessary, the die can be polished by placing it in a lathe, then using very fine emery paper and diamond powder to polish the surface of the die.

5. The die is worn out if the coating layer inside the die shows visible signs of damage. Change to a new NCDC Composite die (but the worn die may still be used as a normal TC die).

Specifying Nano-Dies:

There are up to six parameters to specify:

1. Be sure to specify the Material being Drawn (usually Stainless Steel up to ½ Hard, Welding Rod, Low Carbon Steel Tube or Copper or Brass Tube (without a float die).

2. Specify the bore of the die

3. Specify the required Casing Dimensions (Diameter and Height).

4. Specify the Incoming Wire or Tube Diameter.

5. If the die geometry of the dies currently in use is known, please also provide this information as a benchmark.

6. For Tube Drawing, please also specify the Incoming Wall Thickness and the Target Finished Wall Thickness and the Target Outside Tube Diameter.

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