Nickel Vapor Deposition (NVD)
Shell Tooling & Product Applications

September 2007

Rob Sheppard, P. Eng
Vice-President
Weber Manufacturing Technologies Inc.
Overview of Weber
Company History

1962  Established Weber Manufacturing (Windsor) Limited
1967  Relocated to a new building in Midland, Ontario
       Established the Weber Tool & Mold Division
1989  Established the Nickel Tooling Technology (NTT) Division
1991  Sold our first Nickel Shell
1998  Built and tested NVD Pilot Plant
1999  Designed and Built Large Scale NVD Plant
2000  Commissioned the NVD Nickel Division
       Produced our first Nickel Shell in February
High Quality, Large Class A Compression Molds

NVD Nickel Shells & Molds

Nickel Products
Why Choose Weber

Four key Advantages of Nickel Shell Tooling

1. Solid, stress free nickel shells created by the NVD process are accurately deposited on precision, CNC machined metal mandrels. High accuracy and repeatability from a single, re-usable master.

2. Speed to market: Deposition rates of 0.010inch/hour allow nickel shell tools to get to market ahead quickly. A 5mm thick nickel shell is produced in 20hrs., regardless of size.

3. Highest fidelity replication of authentic surface detail; leather grains, wood grains or engineered textures into high volume production nickel shell tooling.

4. Nickel shell tooling affords conformal heating & cooling designs which support shorter cycle times and uniform mold face temperatures.
NVD NICKEL SHELL

1. Density = 8870 kg/m³
2. Thermal Expansion = 13.1 x 10⁻⁶ mm/mm °C
3. Thermal Conductivity = 88 W / m °C
4. Hardness = 30-42 Rc
5. Lighter mold (shell), heat and cool quickly
6. Conformal Heating/Cooling = uniform mold face temperature
7. Corrosion resistant
8. Replicates from same CNC machined mandrel

P20 TOOL STEEL

1. Density = 7800 kg/m³
2. Thermal Expansion = 12.6 x 10⁻⁶ mm/mm °C
3. Thermal Conductivity = 29 W / m °C
4. Hardness = 27-55 Rc
5. Heavy mold (solid block), high thermal inertia
6. Rectilinear Gundrilled Heating/Cooling circuits
7. Not corrosion resistant
8. Each cavity CNC machined
2 Market Approach
Key Market Areas

- Automotive
- Home/Building Products
- Aerospace
3

Markets
Automotive Interiors
Automotive Interiors

- Tooling for all automotive interior components (i.e. Instrument Panels, Gloveboxes, Doors, Armrests, Middle Consoles, etc.). The only exceptions are high pressure thermoplastic injection parts.
- Molds generally consist of NVD nickel shell cavities.
- Parts are “soft touch” or “leather like” with a leather or technical grain.
- Main molding processes employed:
  - Polyurethane (PU) Spray Skin
  - Direct Backfoam (DBF) -> PU Skin & Foam
  - Slush or Cast Skin (PVC, TPO and TPU materials)
  - Reaction Injection Molding (RIM)
  - Vacuum Forming
- Weber NVD advantages in this segment:
  - Superior and repeatable grain replication.
  - Excellent mold durability -> 30-42 HRc
  - Fast Process -> 0.25mm/hr
  - Excellent mold release characteristics.
  - Conformal heating/cooling -> faster cycle times.
  - Excellent weldability -> welds like steel.
  - Duplicate shell/mold delivery times -> ~2-4 weeks
  - Accurate -> ~ +/- 0.25mm
Customers – OEM, Tier 1 & 2
DaimlerChrysler Programs

M-CLASS (IP, DOORS, GLOVEBOX & MIDDLE CONSOLE)

SLK (IP, DOORS AND GLOVEBOX)
Daimler Chrysler Programs

IP, GLOVEBOX, ARMRESTS, MIDDLE CONSOLE & COVER PANELS (COMMON TO BOTH VEHICLES)

A-CLASS

B-CLASS
GM Programs

BUICK LACROSSE DOORS

CADILLAC SRX DOORS

CADILLAC STS IP & DOORS
Nissan Programs

QUEST IP

ARMADA IP
Automotive Interior Mold Types

DIRECT BACKFOAM IP MOLD BUILD
Direct Backfoam (DBF) Molds

DAIMLERCHRYSLER INSTRUMENT PANEL

DAIMLERCHRYSLER DOOR PANELS
Spray Molds

IP LOWER DRIVER MOLD (M-CLASS)

MIDDLE CONSOLE MOLD (R-CLASS)

FRONT ARMREST MOLD (A-CLASS)
Slush Molds

HOT OIL DOOR MOLD (BUICK LACROSSE)

HOT AIR COCKPIT MOLD (RANGE ROVER)
RIM Molds

RIM SKIN INJECTION MOLD (RANGE ROVER IP TOPPER)

RIM PU OVERMOLD (BMW 6-SERIES CABRIOLET COVER PANEL)

SPE PLASTICS AWARD

RIM Molds

ISO 9001:2000 Registered
www.webermfg.ca
NVD TEXTURED NICKEL SHELL PROCESS FLOW

- CAD Data, Engineering information, and Purchase Order. Design model, mandrel and mold.
- CNC Machine Master Model
- Handwork Master Model
- Pre-etch Commissioning
- Etch Master Model
- Final Commissioning
- Build Support Frame
- Cast Silicone Negative
- Cast Silicone onto Mandrel
- Nickel Vapour Deposition Process
- Shell Stripping and Mold Assembly
- Mold Inspection and Approval

Repeat Steps for Multiple Molds/Shells
CNC MACHINING OF STEEL MASTER MODEL

• Master models are machined from large blocks of P20 tool steel on precision 5-Axis CNC machines.
ETCHED STEEL MASTER MODEL

• Steel master models are packaged and shipped to the etching company selected by the customer.
• The positive part texture is acid etched into the model.
• The model is commissioned by the OEM and the customer.
• Master models are returned.
INSPECTION AND FINAL COMMISSIONING
OF MASTER MODEL

• Master models are re-inspected after etching.
• Model is now ready for patented replication process to prepare mandrel for NVD.
BUILD SUPPORT FRAME

- The support frame is used to support the silicone negative over the master model.
- It is offset from the model, and CNC machined or laid-up off of the master model.
SILICONE NEGATIVE

- Silicon is cast between the support and the master model.
- The silicone negative is used to transfer the texture from the master model onto the mandrel.
CNC MACHINE STEEL MULTI-PIECE MANDREL

- Multi-piece steel mandrel is CNC machined to CAD data
- Data is offset 1.5 mm smaller to provide for silicone skin
- Mandrel is manufactured simultaneously with the master model.
CAST SILICONE ONTO MANDREL

• The mandrel is positioned onto the support frame.
• 1.5 mm of silicone is cast between the mandrel and the silicone negative.
• The texture from the silicone negative is exactly replicated onto the mandrel.
NICKEL VAPOUR DEPOSITION

- The mandrel is placed in the deposition chamber and heated to approximately 180°C.
- Nickel is deposited onto the mandrel at a rate of 0.25 mm/hr
- Mandrel must be cleaned and prepared prior to each deposition.
SHELL STRIPPING

- Proprietary mandrel carefully stripped from the nickel shell.
- The mandrel is cleaned and prepared for subsequent nickel depositions.
- The shell proceeds to mold build.
New Developments

LEATHER WRAPPED MODELS TO EPOXY MASTER MODELS (MAZDA PROGRAM)

NEGATIVE VACUUM FORMING AND IN-MOLD GRAINING PROJECTS (BMW ARMREST)

.010” VACUUM HOLES EVERY 10mm
6

NVD Operations
Concept

Nickel Powder  Solid Nickel Shape
Chemical Process

Ni
nickel powder

+ 4CO
carbon monoxide

Ni(CO)₄
nickel carbonyl

Ni
solid nickel

+ 4CO
carbon monoxide
Main Processing Steps of NVD Technology

1. Carbonyl Generation
2. Carbonyl Evaporation & Nickel Deposition
3. Environmental Control System
Carbonyl Generation

- Ni Hopper
- Condenser
- Reactor
- Liquid Carbonyl
- CO
Carbonyl Evaporation & Nickel Deposition

- Liquid Carbonyl
- Vaporizer
- Decomposition Chamber
- Mandrel
- Mandrel Heater
Environmental Control System

- Most CO and Ni(CO)₄ is recycled
- Waste gases
- Thermal Oxidizer
- Bag House
- Stack
- Air, CO₂, N₂
- Natural Gas
- Air

Nickel Oxide
Deposition Methods

• In-chamber Deposition

• Hollow Deposition
In-Chamber Deposition
In-Chamber Deposition
NVD Material

- It is a very pure material (99.99% nickel)
- It is very corrosion resistant
- Very high thermal conductivity (2.5 times higher than tool steel)
- It can be very ductile, comparable to aluminum
- It welds extremely well (sulfur free, unlike electroformed nickel)
- Virtually a stress-free material (unlike electroformed nickel)
- Very uniform deposition thickness (better than electroformed nickel)
- Very good mold release properties
NVD Nickel Shell

1. 25mm per 100 hr deposition rate
2. Uniform thickness & temperature
3. Negligible residual stress
4. Cavities made sequentially from the same mandrel
5. Little variation from cavity to cavity
6. Replace damaged shell in 3 weeks
7. Hollow deposition possible in many cases
8. 0.999 pure Ni – weldable and no delamination
9. No environmental impact (closed system)

Electroformed Ni Shell

1. 25mm per 2000 hr deposition rate
2. Shell thickness is not uniform
3. Inherent residual stresses
4. Cavities made simultaneously from different mandrels
5. Problematic variation from cavity to cavity
6. Replace damaged shell in 16-30 weeks
7. Cannot do hollow
8. Sulfates contamination from electroplating bath – difficult welding + de-lamination risk
NVD Product Development – Aerospace Components

- Weber is currently developing procedures to deposit nickel on nozzle components and create solid nickel shell components
NVD Product Development – Fuel Injectors

- Weber is developing procedures to coat fuel injectors. This is a development project to reduce gas emission in trucks.

- Application is for large truck engines with initial expected use of 1 million injectors per year.
NVD Product Development – Nickel Coated Particles

- NVD is one of the few processes capable of coating particulates.
- NVD appears to be very cost effective for this process.
- Weber is currently making samples of the materials
- Current uses for coated powder include:
  - Cutting tools;
  - Abrasives;
  - EMI shielding/fire retardant;
4

Other Applications
Home & Building Products
Injection & Compression Molds

- Using Weber’s exclusive Nickel Grain Technology, authentic textures and grains can be reproduced using Compression Molding processes.
Compression – Home & Building

COMPRESSION MOLDS FOR RESIDENTIAL FIBERGLASS ENTRY DOORS WITH AUTHENTIC REPLICATION OF WOOD GRAIN.
CUSTOMER: THERMA TRU DOORS
Injection – Home & Building

2 CAVITY MOLD FOR RESIDENTIAL ROUGH SAWN SIDING; CUSTOMER NAILITE.
Home & Building – Composite Product Development
Development of Compression Molds for Authentic Cedar Shake Siding Panels using NVD nickel shells

Development of Compression Molds for an Authentic Rustic Outdoor Table using NVD nickel shells
Other Applications
For NVD Nickel Shells
**Home & Building – Shells for Sink Molds**

- NVD Nickel Shells for composite kitchen sinks (e.g., Granite filled PMMA)
- Excellent mold release
- Excellent uniformity > uniform mold face temperatures
- Durable, fast, accurate > within 0.005in to CAD data
- NVD shell molds replaced aluminum production tools for Dupont and Villeroy Boch with significant cost savings.
NVD Shells – Injection/Compression Molding

- Kitchen Sink & Bathtub Products - Molded with NVD shells
- Dupont Sink production cycle cut in half (*Moldmaking Tech. Magazine, October 2004*)
Automotive – Low Pressure Composite Parts

• Large parts using low pressure processes have utilized NVD tooling

• Developments in materials and processes such as Resin Infusion, Autoclave and RTM will take good advantage of NVD tooling
Larger Resin Transfer Mold (RTM)

Complete Nickel Shell Mold

Extended Roof on MAN Truck

MAN Truck Roof Manufactured
By Fritzmeier Composites

Received Innovation Award for
Best
Industrial Application 2000

Assembly of Nickel Shell to Mold Base
Aerospace Tooling – Wide Range of Materials

- NVD Nickel Shell Tools
- Less costly than Invar
- Approx. same cost as Steel, far less costs for rate tools
- More durable and accurate than High Density Foam or Reinforced Epoxy
- More durable than Aluminum
Nickel Shell Molds – Airbus – Encapsulated Heating Lines

Nickel Shell Mold with Encapsulated heating line technology - 25 % cycle time reduction by changing 140C (250F) in 1 minute on a 10mm thick NVD shell.
HEAD OFFICE

16566 Highway 12
P.O. Box 399
Midland, ON L4R 4L1 CANADA

Tel: (705) 526-7896 [Main]
Fax: (705) 526-3818
Web Page: http://www.webermfg.ca

Robert Sheppard
Vice President

Direct: (705) 527 - 2976
Mobile: (705) 527 - 2123
Email: rob.sheppard@webermfg.ca

Alan Gobien
Business Manager
Automotive Interiors

Direct: (705) 527 - 2950
Mobile: (705) 427 - 3600
Email: alan.gobien@webermfg.ca

Bernie Koolwick
US Sales

Direct: (248) 338 - 4440
Mobile: (248) 343 - 3245
Email: bernie.koolwick@webermfg.ca
Questions?