Joining of Two Technologies: Wire Mesh & Plastic to Produce Shielded Plastic Enclosures.

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Abstract: This paper covers the development of and the design details required for molding a wire mesh into an injection molded Plastic Part producing a "Screen Room" effect IN the plastics enclosure.

Development History

Reason for : Replace the very costly and poor performing systems currently used for plastic enclosures , i.e. Painting , Plating and filled resins.

A large number of studies have been completed concerning the use of "screen " for shielding effectiveness and its use in testing labs (as a "Screen Room") . The question and the development of this process is based on and directed toward the manufacturing and designs required to join the 2 technologies , Wire mesh & plastics.

The development required a controlled screen material be developed which could be produced to meet both the emc needs as well as the unique needs of the plastic molding process. The enclosure not only required the grid "molded-in" but the process must be capable of controlling where the grid is located "In the Plastic" both to provide grounding and sealing surfaces , at the same time we must be able to keep the Grid off of the appearance surfaces (must be on the inside).

Requirements for the total process development were:

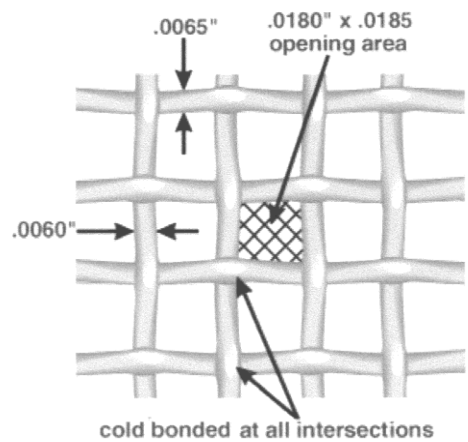
- Must use Standard plastic Design practices .
- Any and all current Resin in use for enclosures.
- Standard Molds , per SEP/SPI.
- No major additional tooling.
- Standard molding machines.
- Out of the press Shielded.

The Mesh Material:

- The Grid aperture must be small enough to provide the highest shielding effectiveness but must allow the plastic to flow through.
- The intersections of the wire must be bonded in such a manner as to provide a solid connection at each point.
- The wire should be made using a ferrous material so as to provide an effective shield. A nickel plated steel material was selected , however the plating is applied prior to the wire being drawn.
- The bonding of the grid provides the solid intersection as well as adding to the ability of the grid to be used in the plastic molding process.
- Ease of forming , and the ability for being stable during the molding process were also main points.

The development produced a number of materials which can be used, in fact a range of grid sizes from .002" dia copper (100 mesh , that is 100 wires per inch in both directions) which is very fine, up to a more cost effective size shown in (*figure 1.)* a 40 mesh ni/St. .0065 dia . Mold test which used a number of thermo plastic resins proved that mesh size as fine as 100 x 100 is not a problem , however larger , more open , such as 18 x 18 does pose problems in terms of controlling the mesh location.

(figure 1.)



The mesh is molded INTO the plastics , (figure 2) and in exposed in areas that are required for grounding , and or in openings for shielded air flow.

figure 2.

The Process.

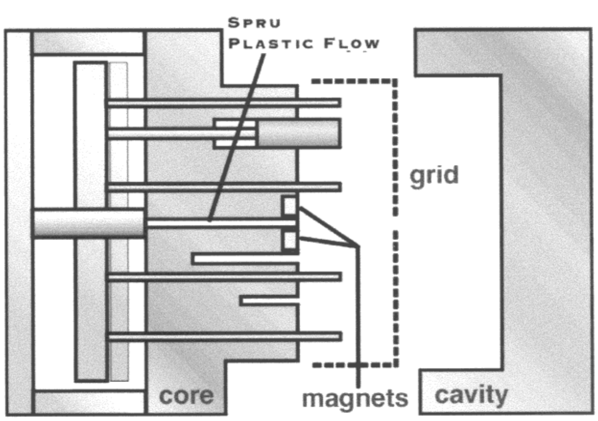
As plastic enclosures grow in use for electronics and the shielding requirements increased it became very clear that we could not simply return to metal housings to solve the EMI problem.

Insert molding has been around for a number of years , connectors are just one product that uses this type of molding. Molding an entire surface and controlling the location of the mesh was the major manufacturing issue.
During the development (mold testing) stage it became very clear that the mesh does not need to be formed to the details of the core , the plastic will complete the Detail forming.
This forming is very beneficial since any complex additional tooling would be to costly for commercial use.
Lower injection pressure and increase material flow were two other benefits which were unexpected. The mesh increases shear, which in the molding process produces additional heat thereby increasing flow & reducing pressure.
Increased material flow means a mesh molded part allows plastic to flow future without the aid of additional gates.

Standard molds (figures 3 & 4) are used with the addition of magnets. The magnets are used to hold the mesh on the core until the mold closes and the resin starts to flow. The presentation will include animations and videos to further demonstrate the molding.

Figure 3 shows the mold in an open position with the ejectors pins forward and the mesh in a pre load position.

figure 3



Flow Through , is the key from the molding standpoint. The mesh openings allows the resins to flow through to fill the part: *(a)* The resin is introduced into the mold it flows into the cavity and contacts the Cavity side *(B)* of the mold , this is the appearance side of the part. The resins than flows along the mesh & cavity steel , as the resins flows to a Rib *(C)* the resins than flows Through the Mesh to fill these areas. The mesh openings that provide the Shield allows the resins to flow.

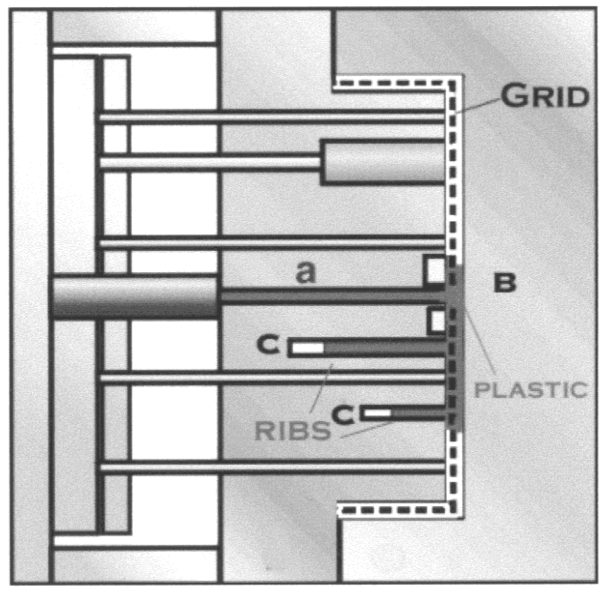


figure 4

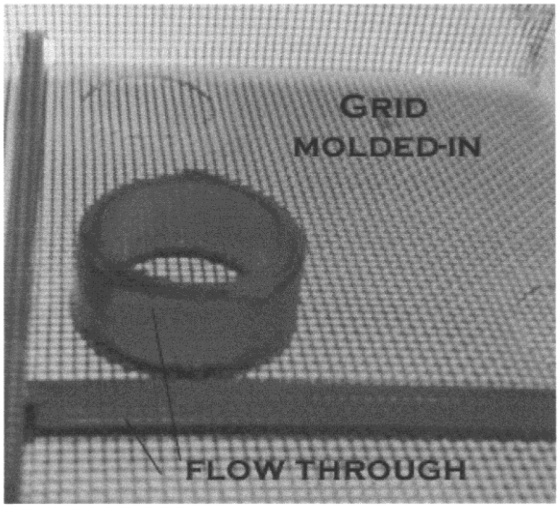
The core details of the part (inside of the part) do not effect the shielding or the process since the mesh is on a constant plain above these details. This is a great advantage over surface coating systems since deep and or complex parts create difficulties for applying coatings in these areas.

The mold testing development required over 1,000 press hours to study the effects of material flow , gating and surface changes .
The mold ing test were extensive , including a wide range of resins used for enclosures as well as all normal set-ups .
The test confirmed that molding the mesh into an enclosure was not only very feasible but could be accomplished within a commercial production system.

However the next stage would require developing design methods to provide grounding and sealing surfaces.

The result as shown below in (figure 5) , the mesh is molded into the part and the ribs and boss's are filled as the mesh allows the resin to flow through.

figure 5



"Part Design for Effective Shielding " requires that the edges or corners of the enclosure be effectively sealed . This is accomplished within the molding process , the plastic flow provide the pressure (over 20,000 psi) to compress the 2 mating grid surfaces together.

The effectiveness of the shielded enclosure depends greatly on the sealing , the molded-in grid can be used as a gasket, since this gasket feature is in fact made of the same piece of mesh there cannot be any loss of conductivity between the main shield and the gasket. see figure 6 & 7.) Not only is the Mesh Folded to form the corner but the mesh is also molded through the hinge.

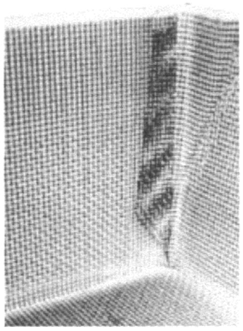


figure 6

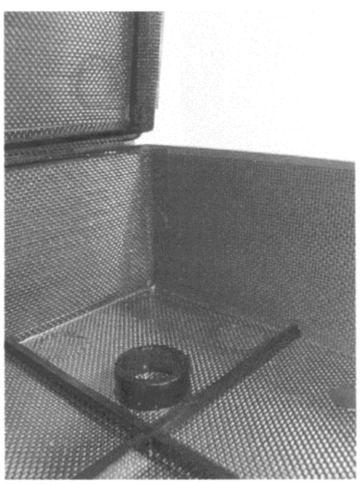


figure 7

Exposing the mesh to be available for sealing and ground contacts required a study of mold building techniques as well as understanding how resins flows. Most engineering resins will not flow into an area or opening of .005" or less , this allow us to place the mesh onto the parting lines of the mold and shut off right on the material. Since the resin will not flow , the mesh remains fully exposed.

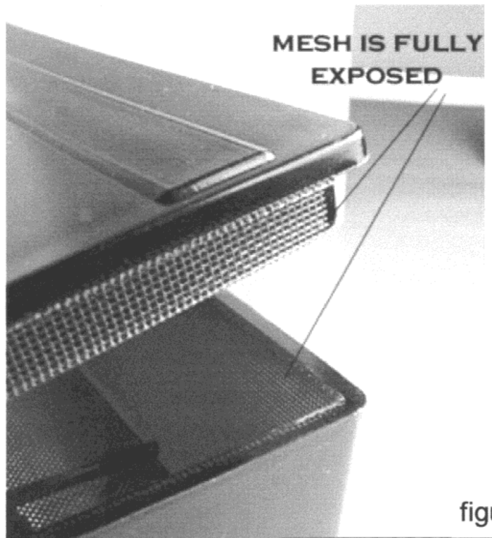
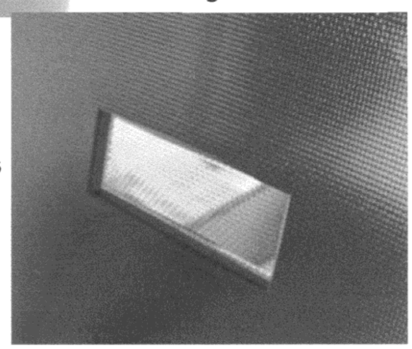


figure 8.

figure 9



This shut off provides another design feature , "shielded air flow" (figure 9) the mesh can be molded across an opening.

The combining of the two technologies , wire and plastics , to form a effective shielded enclosure has also led to a stronger and lighter overall enclosure which would be capable of replacing metal in environments where metal alone fails to meet the standards.

The correct wire material and process will allow Contoured enclosures which have caused and will continue to cause EMC problems using the standard methods , such as sheet metal.
figure a .

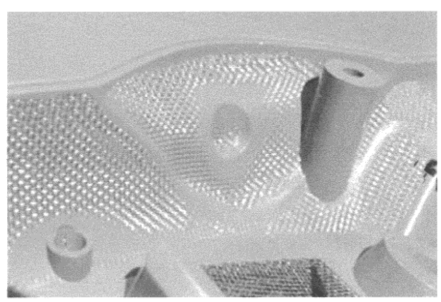
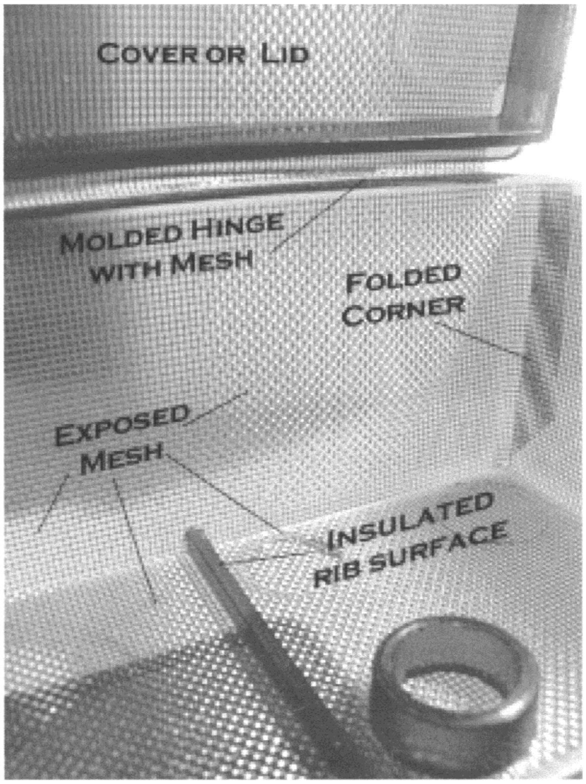


figure a

The mold study along with molding samples proved that the mesh can be exposed and controlled to provide grounding and contact surfaces.



Continuing studies and development are now underway to determine the value in using the process for heat transfer. New material under development such as *figure 11.* a wire grid that contains a wider band of heavier material woven into the mesh which could assist in the transfer of heat. Although this is not an attempt to remove and or replace large Heat Sinks it appears that it will assist in solving another problem that Plastics Enclosures have had.

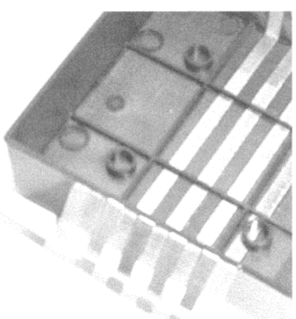


figure 11

Process	Tool	Oper Req.	QC Prob.	Shield Effect.	Design flexibility
Mesh	0-1	1	0-1	very good	Excellent
Paint	Racks & Mask 4	8-13	8	Poor - Good	NA
Plate	Racks/ Masks 6	8-13	8	Poor - Very Good	NA
Filled	Poor Tool Life 8	0	5	Very Poor	poor
Sheet Metal	10	5	5	Good	poor
Die Castings	10	2-4	4	very good	poor

figure 13

figure 13 Shows a table of comparison of a number of existing technologies. The value for each listed is based on a normal plastic cover and the additional cost and or operations required to shield . Scale of 1-10. The sheet metal & die castings notes reflect making the same part . i.e. Normal plastic part requires a standard mold so the "tooling" =0 , mesh molded part uses the same mold .
Normal Plastics Part.
Tooling =0 , Oper Req. = 0 , QC =0

Summary:
With the correct mesh material and understanding the injection molding & design this process can produced a high quality shielded enclosure which does not cause the typical problems that surface coatings cause and at a much lower cost. This development has lead to the approval by a number of companies for production replacing sheet metal and die castings.