Abstract: A laminated sheet metal is comprised of a first sheet of metal and a second sheet of metal that are adhered together by a polymer layer core that is interposed between the two sheets and provides visco-elastic adhesion. The polymer layer has at least one region of a first polymer material that is selected for optimal viscous and elastic qualities by which to dampen the transmission of noise and vibration between the sheets, and at least one other region of a second polymer material that is selected for optimal adhesive qualities by which the sheets are optimally joined together against delamination. Thus the laminated sheet metal can be tailored to optimize the qualities that are desired for the manufacture of a particular product.
TAILORED CORE LAMINATED SHEET METAL

TECHNICAL FIELD

[0001] The present embodiments relate to a laminated sheet metal material having a polymer core tailored to provide varying regions of metal adhesion and vibration dampening.

BACKGROUND

[0002] It is known in modern automobile manufacture to employ laminated metal, particularly laminated steel, in the forming of components such as oil pans, rocker covers, wheelhouse inners and front-dash structures. Laminated metal is comprised of two sheets of metal, such as steel, aluminum or magnesium, with a layer of polymer interposed therebetween.

[0003] The polymer core layer acts to adhere the metal sheets together and also provides a visco-elastic coupling between the metal sheets that dampens noise and vibration.

[0004] The laminated sheet metal can be shaped by known metal forming processes such as stamping. Laminated metal is known to provide a good combination of vibration damping properties and high strength-to-weight ratios and is accordingly of interest to meeting the exacting performance demands of a variety of industries.
It would be desirable to provide a laminated sheet metal, which could be tailored to provide optimal characteristics of metal adhesion and vibration damping properties.

SUMMARY

A laminated sheet metal may be comprised of a first sheet of metal and a second sheet of metal that are adhered together by a polymer layer core that is interposed between the two sheets and provides visco-elastic adhesion. The polymer layer has at least one region of a first polymer material that is selected for optimal viscous and elastic qualities by which to dampen the transmission of noise and vibration between the sheets, and at least one other region of a second polymer material that is selected for optimal adhesive qualities by which the sheets are optimally joined together against delamination. Thus the laminated sheet metal can be tailored to optimize the qualities that are desired for the manufacture of a particular product.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will become more fully understood from the detailed description and the accompanying drawings, wherein:

Figure 1 is a perspective view of a laminated sheet metal having island-like regions of adhesive dispersed within the visco-elastic material;
[0009] Figure 2 is a view similar to Figure 1 but showing an alternative embodiment in which adhesive material is placed in the regions along the edge of the sheet metal laminate and the visco-elastic material is located in regions further away from the edges of the laminated metal;

[0010] Figure 3 is another embodiment of the invention in which the polymer core between the metal plates is formed by alternating strips of adhesive material and visco-elastic material; and

[0011] Figure 4 is a perspective view of a vehicle seat pan construction stamped from the laminated sheet metal.

DETAILED DESCRIPTION OF THE EXEMPLARY EMBODIMENTS

[0012] The following description of certain exemplary embodiments is merely exemplary in nature and is not intended to limit the invention, its application, or uses.

[0013] Referring to Figure 1, it is seen that a laminated sheet metal panel or strip 10 is comprised of an upper or top metal sheet 12 and a lower or bottom metal sheet 14 that are joined together by a polymer core layer 16. The metal sheet 12 and the metal sheet 14 may be steel or aluminum or magnesium or some other metallic material or alloy. Interstitial steel is often used, and one or both of the metal sheets 12 and 14 can have a galvanized coating, on either both sides of the sheet or on a single side of the sheet.
As seen in Figure 1, the polymer core layer 16 is comprised of several spot or island regions 20 of a first polymer material 22, and a surrounding larger region 24 of a second polymer material 26. The first polymer material 22 is selected from among the commercially available polymers primarily for its adhesive characteristics, and the second polymer material 26 is selected from among the commercially available polymers primarily for its visco-elastic characteristics. Thus, although each of the polymer materials 22 and 26 will have both adhesive and visco-elastic characteristics, the first polymer material 22 may have adhesive qualities that are superior to the adhesive qualities of the second polymer material 26, and the second polymer material 26 has visco-elastic qualities that may be superior to the visco-elastic qualities of the first polymer material 22.

Accordingly, the product designer can tailor the core of the laminated sheet metal 10 to provide selected regions 20 of high adhesion interspersed among the other region 24 of high visco-elastic qualities. An example of a first polymer material 22 that would be chosen for its adhesive qualities is an epoxy. An example of a second polymer material 26 that is chosen for its enhanced visco-elastic damping qualities is a styrene-ethylene/butylene-styrene (SEBS) based polymer.

It will be understood that the laminated sheet metal 10 of Figure 1 can be formed in a continuous strip manufacturing process where the metal sheets 12 and 14 are progressively unrolled from coils of sheet material.
Alternatively, the laminated sheet metal 10 of Figure 1 can be manufactured by first blanking the top metal sheet 12 and the bottom metal sheet 14 from a coil or a blank, and then applying the polymer materials 22 and 26 between the two blanks.

[0017] Referring to Figure 2, another laminated sheet metal panel or strip 30 is shown having an upper metal sheet 32 and a lower metal sheet 34. In the example of Figure 2, a first polymer material 35 selected for its adhesive qualities is provided at a left edge strip 36 and right edge strip 38 of the laminated sheet metal 30. In addition, this first polymer material 35 is also located in a longitudinal strip 40 along the center of the laminated sheet metal 30, and at crossbars 42, so that the first polymer material 35 will form a latticework 43 of high adhesion characteristic that will adhesively bond the metal sheets 32 and 34 together. Figure 2 also shows that a second polymer material 44 is located in the some of the interstices of the latticework 43 formed by the first polymer material 35, and a third polymer material 46 is located in some of the interstices of the latticework 43. The second polymer material 44 and the third polymer material 46 are selected for their visco-elastic characteristics, and thus allow the design of a laminated sheet metal 30 that will have varying visco-elastic qualities at selected areas of the laminated sheet metal 30. Thus, as seen in Figure 2, the metal sheets 32 and 34 will be effectively bonded together by the latticework 43 of the adhesive first polymer material 35 and the larger interstices or regions between the strips 36, 38, and 40 and the crossbars 42 of the first
polymer material 35 will be occupied by the visco-elastic materials 44 and 46 to effectively and variably dampen the transmission of noise and vibration through the laminated sheet metal 30.

[0018] Referring to Figure 3, a third embodiment of the invention is shown where a laminated sheet metal 60 includes an upper metal sheet 62 and a lower metal sheet 64 having a polymer core 66 therebetween which is provided by alternating strips 70 of a first polymer chosen for its adhesive qualities and a second polymer 72 chosen for its visco-elastic damping qualities. In this way, alternating strip regions of high adhesion and high visco-elastic qualities can be readily laid down for coil processing by passing the lower metal sheet 64 beneath a row of polymer-dispensing nozzles or by mounting a row of nozzles on a robotic arm which passes over top the lower sheet 64. If desired, two or more different polymers can be used for their adhesive qualities and two or more different polymers can be used for their visco-elastic damping qualities. The width of the strips can be varied as desired.

[0019] Figure 4 shows a cup-shaped product 80, such as an oil pan, or a vehicle seat pan, which has been stamped from the laminated sheet metal 10 having alternating regions of first and second polymers.

[0020] The laminated sheet metal 10 can be particularly tailored to optimize the qualities that are desired from the manufacture of the particular product, such as the cup-shaped tub product 80, shown in Figure 4. The tub 80 has a peripheral rim flange 82 extending around the outside thereof where the
edges of the upper metal sheet 12 and lower metal sheet 14 will be exposed to the elements, including potentially, moisture, salt, and solvents. Accordingly, the designer may choose to employ a more adhesive polymer at those regions of the laminated sheet metal 10 that are destined to become the flange 82 of the stamped sheet metal tub 80, to thereby maximize the adherence of the upper metal sheet 12 and lower metal sheet 14 to guard against the possibility of delamination at the edges of the tub 80.

[0021] Furthermore, during the sheet metal forming process, such as stamping or deep-drawing to form the cup-shape of the tub 80, the laminated sheet metal 10 will be subjected to a shear and compressive forces to sever the laminated sheet metal 10 around the flange 82 and various shear and compressive forces to draw the depth of side wall 84 of the tub 80. Accordingly, the designer may choose to employ a more adhesive or less adhesive polymer at those regions of the laminated sheet metal 10 that are destined to be stressed during the forming process.

[0022] In other regions of the tub 80, such as the generally planar bottom wall 86, the designer may choose a more visco-elastic polymer, or more than one visco-elastic polymer to optimize the noise and vibration dampening characteristics of the large planar bottom wall 86.

[0023] In view of the foregoing, it will be appreciated that a skilled designer of products can tailor a laminated sheet metal in a way that accomplishes the best optimized tradeoff of the adhesive and visco-elastic
characteristics desirable for the finished product. The polymers can be
dispensed in the paths and patterns shown in Figure 1-3, and in variation thereof.
Any number of two or more different polymers can be used. In addition, although
the drawings show just two sheets of metal adhered together, a plurality of metal
sheets can be used to form the laminated sheet metal by stacking alternating
layers of sheet metal and polymers.
CLAIMS

What is claimed is:

1. A laminated sheet metal comprising:
   a first sheet of metal and a second sheet of metal;
   a polymer layer interposed between the first and second sheets to provide visco-elastic adhesion between the sheets, said polymer layer being of at least one region of a first polymer material selected for optimal adhesive qualities by which the sheets are joined together against delamination, and at least one region of a second polymer material selected for optimal viscous and elastic qualities by which to dampen the transmission of noise and vibration between the two sheets.

2. The laminated sheet metal of Claim 1 further comprising:
   said first polymer material being provided at least along the edge portions of the sheets to provide optimal bonding of the sheets against delamination at the edges.

3. The laminated sheet metal of Claim 1 further comprising at least one of said first and second sheets having a galvanized coating on at least one face thereof.
4. The laminated sheet metal of Claim 1 further comprising a plurality of first regions of the first polymer being surrounded by a second region of the second polymer.

5. The laminated sheet metal of Claim 1 further comprising a plurality of second regions of the second polymer being surrounded by a first region of the first polymer.

6. The laminated sheet metal of Claim 1 further comprising one of the first and second regions being a latticework of one of the polymer materials, said latticework having interstices and the other region being the interstices of the latticework.

7. The laminated sheet metal of Claim 1 further comprising the at least first region and the at least second region being alternating strip regions.

8. A laminated sheet metal comprising:
   a first sheet of metal and a second sheet of metal;
   an adhesive material bonding the first sheet and the second sheet at certain selected regions therebetween to obtain desired adhesion between the sheets at the certain selected regions;
and a visco-elastic material bonding the first sheet and the second sheet at other selected regions therebetween to obtain desired noise and vibration dampening at the other selected regions.

9. The laminated sheet metal of Claim 8 further comprising said adhesive material and said visco-elastic material being two different polymer materials.

10. The laminated sheet metal of Claim 8 in which both the adhesive material and the visco-elastic material have some adhesive characteristics and visco-elastic characteristics and the adhesive material is a polymer having adhesive characteristics greater than the adhesive characteristic of the visco-elastic material and the visco-elastic material is a polymer having visco-elastic characteristics greater than the adhesive characteristics of the adhesive material.

11. The laminated sheet metal of Claim 8 in which the region of adhesive material is at least that region that will become the edge portion of a product that is formed from the laminated sheet metal to provide adhesion against delamination.

12. The laminated sheet metal of Claim 8 further comprising the region of adhesive material being at least that region of the laminated sheet metal that
will be subjected to forming-induced stresses so as to provide adhesion against delamination during metal forming operations to which the laminated sheet metal will be subjected in forming a product.

13. The laminated sheet metal of Claim 8 further comprising the region of visco-elastic material being at least that region of the laminated sheet metal that will benefit from adhesion against delamination and the region of the adhesive material being at least that region of the laminated sheet metal that will benefit from visco-elastic action to dampen the transmission of noise and vibration.

14. A laminated sheet metal comprising:

- a first sheet of metal and a second sheet of metal;
- at least one adhesive material bonding the first sheet and the second sheet at certain selected regions therebetween to obtain desired adhesion between the sheets at the certain selected regions;
- and at least one visco-elastic material bonding the first sheet and the second sheet at other selected regions therebetween to obtain desired noise and vibration dampening at the other selected regions.
15. The laminated sheet metal of Claim 14 further comprising two different adhesive materials bonding the first and second sheets together at the certain selected regions.

16. The laminated sheet metal of Claim 14 further comprising two different adhesive materials bonding the first and second sheets together at the other selected regions.
## A. CLASSIFICATION OF SUBJECT MATTER

**B32B 15/06(2006.01)1, B32B 7/12(2006.01)1**

According to International Patent Classification (IPC) or to both national classification and IPC

## B. Fields Searched

Minimum documentation searched (classification system followed by classification symbols)

IPC B32B 15/06, B32B 7/12

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean Utility models and applications for Utility models since 1975

Japanese Utility models and applications for Utility models since 1975

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKIPASS (KIPO INTERNAL) "sheet", "damping", "adhesive"

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category*</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>JP 04-216040 A (MITSUBISHI MOTORS CORP) 06 August 1992 See paragraph 7 to paragraph 10, claim 1</td>
<td>1-16</td>
</tr>
<tr>
<td>A</td>
<td>KR 10-622024 B1 (ACOUSTIC &amp; VIBRATION TECHNOLOGY CO., LTD) 01 September 2006 See page 2, line 39 to page 3, line 45, claims 1-6</td>
<td>1-16</td>
</tr>
<tr>
<td>A</td>
<td>JP 05-177762 A (NKK CORP) 20 July 1993 See paragraph 5 to paragraph 17, claims 1-3</td>
<td>1-16</td>
</tr>
<tr>
<td>A</td>
<td>WO 96/23163 A1 (MINAKAMI HIROYUKI, MINAKAMI MOTOYUKI) 01 August 1996 See page 16, line 20 to page 21, line 27, claims 1, 12</td>
<td>1-16</td>
</tr>
</tbody>
</table>

* Special categories of cited documents
  - "A" document defining the general state of the art which is not considered to be of particular relevance
  - "E" earlier application or patent but published on or after the international filing date
  - "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of citation or other special reason (as specified)
  - "O" document referring to an oral disclosure, use, exhibition or other means
  - "P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance, the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance, the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

29 OCTOBER 2008 (29 10 2008)

Date of mailing of the international search report

29 OCTOBER 2008 (29.10.2008)

Name and mailing address of the ISA/KR

Korean Intellectual Property Office
Government Complex-Daejeon, 139 Seonsa-ro, Seo-gu, Daejeon 302-701, Republic of Korea

Facsimile No 82-42-472-7140

Authorized officer

CHOI Eun Serk

Telephone No 82-42-481-8444

Form PCT/ISA/210 (second sheet) (July 2008)
<table>
<thead>
<tr>
<th>Patent document cited in search report</th>
<th>Publication date</th>
<th>Patent family member(s)</th>
<th>Publication date</th>
</tr>
</thead>
<tbody>
<tr>
<td>JP 04-216040 A</td>
<td>06.08.1992</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>KR 10-0622024 B1</td>
<td>01.09.2006</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>JP 05-177762 A</td>
<td>20.07.1993</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>WO 96/23163 A1</td>
<td>01.08.1996</td>
<td>AU1467395A</td>
<td>14.08.1996</td>
</tr>
</tbody>
</table>

Form PCT/ISA/210 (patent family annex) (July 2008)