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*An examination of the causes of damaged or defective jewellery returned by customers in the UK shows that many complaints are focused on platinum and white gold jewellery, particularly rings. In this presentation, an analysis of complaints over the last 2 years is made and focuses on the most common problems and their causes. For example, cast rings are often heavily marked and worn and frequently distorted in shape with gem stones missing or loose. This is due in part to the modern lifestyle of women and is related to the relative softness of the alloys and poor design from an engineering viewpoint.*
*Other common areas of complaint include rhodium plating of white golds and the lack of durability and tarnishing of silver and items electroplated with gold. It is clear that some of these problems are due to poor manufacturing practice and some to customer usage. This analysis suggests that jewellery manufacturers manufacture for ease of manufacturing at the expense of good performance in service with the customer and begs the question of whether some jewellery is for for purpose in the modern age.*

# "Jewellery – Is it fit for purpose? An analysis based on examination of customer complaints"

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## INTRODUCTION

In the UK, if a customer has a complaint about the quality or performance of their jewellery, the retailer can send it off, often via his Association, The National Association of Jewellers, for an independent examination by a technical expert at the Worshipful Company of Goldsmiths (who also run the London Assay Office). The expert examines the item of jewellery and makes an assessment of the problem (damage and defects) and its probable cause. He also indicates where he considers the blame lies – the customer, retailer or manufacturer. This helps to resolve the dispute.

For many years, my good colleague, Mark Grimwade, has been that expert but for the last 2 years, I have taken on that role. We have limited facilities in-house and rely chiefly on a zoom microscope and the analytical facilities of the London Assay Office. Typically this latter involves analysis of alloys and solders by X-Ray Fluorescence analysis (XRF) and coating thickness measurements. In some instances, we may go outside to access other facilities such as hardness and metallography, but in most cases we try to avoid destructive test methods.

Over the last 3 years, we have examined 109 cases, each involving mostly one item of jewellery, but sometimes there may be several items for examination, e.g. a pair of earrings or rings. From such assessments, it has been clear to me that in several instances the quality of manufacture (embracing design aspects too) is inadequate in some way and therefore, we can consider the item is not fit for purpose. In many others, the main cause of the problem has been due to harsh treatment by the customer.

## JEWELLERY DESIGN: ARTISTIC OR ENGINEERED?

It is probably true to say that most jewellery designers have qualified in design in arts rather than engineering disciplines. They are artists, not engineers! Thus, jewellery is designed and made primarily from an artistic point of view, i.e. how it looks when worn by the consumer. Most jewellery today is designed by CAD and the programmes for jewellery are based on artistic rather than engineering guidelines1. Often the manufacturer selects materials and processes that ease his production of the item. Rarely, in my experience, does the designer and manufacturer consider the design from an engineering standpoint and does not consider making the piece for optimum performance when worn by the customer[2].

The problem of jewellery being 'fit-for-purpose', i.e. designed and made to suit the application for which it is intended has been discussed in several papers at the Santa Fe Symposium and the Jewellery Technology Forum, often in terms of appropriate testing methods for finished jewellery[3-10]. A problem here is that there are no recognised national and international standards for jewellery and jewellery testing that address this aspect, apart from precious metals contents. It is, therefore, instructive to analyse customer complaints to see what type of product and problem occur most frequently and whether lessons can be learned. In this analysis we look at the following aspects:

a) Type of product
b) Precious metal involved
c) Problem involved in complaint
d) Where the fault for problem lies

**CUSTOMER COMPLAINTS – TYPE OF PRODUCT**

Of the 109 cases examined since January 20015, the overwhelming product subject to complaints are rings, usually gem-set. As Table 1 shows, this amounts to 82% of complaints in terms of items examined (but 88% in terms of cases submitted), with 63% being gem-set. These latter comprise a range of types: rings with gem-stones set in a mount, some with additional gems set on the shoulders, and eternity rings – including some half eternity rings with only half the circumference set with stones. The number of plain rings submitted is quite small in comparison, just over 13%.

| Product | Number of items | Proportion of total items, % |
|---|---|---|
| Rings - total | 98 | 81.7 |
| Rings – gem-set | 82 | 63.3 |
| Rings – plain | 16 | 13.3 |
| Bracelets | 6 | 5.0 |
| Necklace/ pendants | 6 | 5.0 |
| Beakers | 2 | 1.7 |
| Cuff links | 2 | 1.7 |
| Watch bracelet | 1 | 0.8 |
| Earrings | 3 | 2.5 |
| Locket | 1 | 0.8 |
| Other | 1 | 0.8 |
| Total items | 120 | 100 |

Table 1 Analysis of type of product subject to complaint

**CUSTOMER COMPLAINTS – TYPE OF PRECIOUS METAL**

**A] Rings:** Focussing on the rings only, Table 2 shows the type of precious metal from which the rings are fabricated. The table lists the total gold and the amount of white gold rings, since white gold is a major portion of total gold. In nearly all the gem-set ring cases, they are made by investment (lost wax) casting. The plain rings, generally wedding bands, are typically wrought.

| Product | Gold (total) | White gold | Platinum | Palladium | Silver |
|---|---|---|---|---|---|
| Gem-set | 45 | 35 | 33 | 3 | 1 |
| Plain | 9 | 4 | 2 | 1 | 4 |
| Total | 54 | 39 | 35 | 4 | 5 |
| Proportion of total, % | 39.4 | 28.5 | 25.5 | 2.9 | 3.6 |

Table 2 Analysis of type of precious metal used in the rings

This clearly shows the major portion of rings were gold, with white gold comprising nearly three-quarters of the gold rings.
A substantial portion – about one quarter - were platinum with palladium and silver at very low numbers.

If we analyse the gold rings in more detail, Table 3, we find that just over 70% are white gold, split evenly between 18 carat (750 fineness) and 9 carat (375 fineness). Yellow gold is the next major colour at 21.4%. In terms of caratage, just over half are 18 carat (53.6%) and 44.6% are 9 carat

| Carat & colour | Number of rings | Proportion of total, % |
|---|---|---|
| 22Y | 1 | 1.8 |
| 18Y | 7 | 12.5 |
| 18W | 20 | 35.7 |
| 18R | 1 | 1.8 |
| 18M | 2 | 3.6 |
| 9Y | 4 | 7.1 |
| 9W | 20 | 35.7 |
| 9R | 1 | 1.8 |

Y = yellow, W = white, R = red/rose, M = mixed yellow & white

Table 3 Colour and caratage (fineness) of the gold rings

Of the platinum rings, all were nominally 95% platinum (950 fineness), although a few were higher in platinum than 95%, as measured by X-ray fluorescence analysis (XRF). Likewise, the palladium rings were all at 950 fineness. The silver rings were all of sterling silver standard, 925 fineness.

**B] Other Items of jewellery:** Looking now at the items that were not rings, Table 4 shows the analysis of precious metals from which they were fabricated

| Product | Gold | Platinum | Palladium | Silver | Stainless steel |
|---|---|---|---|---|---|
| Bracelets | 3 | - | - | 4* | - |
| Necklace/pendants | - | - | - | 6* | - |
| Beakers | - | - | - | 2 | - |
| Cuff links | - | - | - | 2* | - |
| Watch bracelet | - | - | - | - | 1* |
| Earrings | 2 | - | - | 1 | - |
| Locket | 1 | - | - | - | - |
| 0ther | | | | 1* | |
| Total | 6 | 0 | 0 | 16 | 1 |

*gold plated

Table 4. Analysis of type of precious metal used in non-ring items

In contrast to the rings, the major precious metal in this category was silver, of sterling silver quality (925 fineness), much of it gold plated.

**CUSTOMER COMPLAINTS: THE TYPE OF PROBLEM**

In this section the nature of the complaint is analysed. As previously, this analysis is divided into the rings and the other items (non-rings).

**A] Rings:** The nature of the complaints for rings can be separated into several facets. Some occur together, e.g. missing gem stones and heavy scratches and dents, and even misshapen shanks. These are summarised in Table 5

| Nature of complaint | Gem-set rings | Plain rings |
|---|---|---|
| Misshapen | 24 | - |
| Cracks & fractures | 16 | 1 |
| Missing gem stones | 31 | 1 |
| Wear/scratches/dents | 31 | 5 |
| Colour change | 7 | 7 |
| Tarnish/corrosion | - | 7 |
| Allergy | 4 | - |
| Finish/surface porosity | 3 | - |
| Plating issues | 1 | - |
| | | |
| Total | 117 | 21 |

N.b. Colour change may also be a plating issue

Table 5 Nature of complaints with rings (number of items)

Looking at each in more detail, we find that misshapen rings (deformed whilst being worn by the customer) are seen mostly with platinum rings (75%) with the rest being gold, particularly white gold. In contrast, cracks and fractures (to shank or mounting heads) were predominantly seen with gold rings (82%), rest platinum. Missing gem stones, in the mount or shoulders or shank, were seen mostly in gold rings (59%) with platinum also large (37.5%. There was also 1 occurrence in a palladium ring.

Heavy wear, usually typified by scratches, gouges and dents to the shank, was frequently seen, particularly with platinum rings (64%) with gold only about half as frequent (30.5%) and there were two instances for palladium rings.

Colour change was primarily attributed to the yellowing of white gold and due to rhodium plating wearing off, exposing the underlying off-white (yellowish) gold beneath. There was one case of a 'rose' gold plating that faded and another of the shank of yellow gold turning white/grey. This latter was due to contact with mercury. Mercury forms a grey amalgam with carat golds.

As might be expected, the problem of tarnishing occurred on sterling silver rings, including one that had been gold plated. This latter was attributed to pinholes in the gold plating. The issue of a poor finish was mainly due to small porosity on the surface from casting. There was one case of plating issues on gold (rhodium plated instead of requested platinum).

**B] Other Items of jewellery:** As with rings, some problems occur together, e.g. tarnish and plating issues. The nature of complaints is quite different to those on rings, as shown in Table 6.

| Nature | Tarnish | Wear Scratch/dents | Colour change | Plating issues | Mechanical damage |
|---|---|---|---|---|---|
| Bracelets | - | - | - | 5 | 3 |
| Necklace/pendants | 1 | 1 | - | 5 | - |
| Beakers | 2 | - | - | - | - |
| Cuff links | 2 | - | - | 2 | - |
| Watch bracelet | - | - | 1 | - | - |
| Earrings | 2 | - | - | 1 | 1 |
| Locket | - | - | - | - | 1 |
| Other | 1 | - | - | 1 | - |
| | | | | | |
| Total | 8 | 1 | 1 | 14 | 5 |

Table 6 Nature of complaints with non-ring items of jewellery

We note here that plating issues are the major complaint with 14 items affected. Of these, almost all involved gold plating on sterling silver. In some instances, pinholes in the plating resulted in tarnish spreading out from the pinholes over the gold surface. Out of the 8 cases of tarnish, 7 were on sterling silver items and one on yellow gold. The tarnish seen on the sterling silver beakers occurred quickly when the beakers were located in a kitchen. The same beaker design did not tarnish when located in other parts of the house.

Surprisingly, wear (including scratches and dents) was only found on a sterling silver component for a necklace, with heavy wear of the jump ring due to it rubbing on another part of the necklace. The category of mechanical damage concerned broken or damaged clasps or catches on white gold bracelets (3 items), one case of Stress Corrosion Cracking (SCC) in a pair of yellow gold earrings and I case of broken metal on a 9ct white gold locket due to embrittlement. It is worth noting that cases of SCC used to be common in the UK, particularly on 9 ct gold items, but is rarely seen today.

**CUSTOMER COMPLAINTS: WHERE THE FAULT LIES – MANUFACTURER OR CUSTOMER?**

**A] Rings:** As noted earlier, the complaints of **heavy wear,** misshapen rings and loss of stones often occur in together. In many cases of heavy wear – scratches, gouges and dents - the main cause is due primarily to the customer. It tends to occur at the back of the shank in gem set jewellery which is on the palm side of the hand. We should recognise that the modern lifestyle, of women in particular, is quite different to that of women some 30 -50 years ago, when jewellery was often only worn on special social occasions. Nowadays, jewellery tend to be worn much of the time and the lifestyle is more active and physical. Rings get heavy wear and knocks, e.g. on hard surfaces or desks, or get squeezed heavily such as tight gripping of kitchen tools, sports racquets, handles of heavy luggage or even clapping against the other hand that also wears rings. There are instances where the dog has bitten the owner's hand and the force of its jaws has caused the ring to distort. Instances of all such causes have been seen. Often this modern lifestyle also leads to the shanks distorting to an oval shape, such as shown in Figure 1. This in turn can lead to gem stones becoming loose and falling out. We often see instances of this in eternity rings. The sharper bend caused by the deformation opens up the gem setting locally and allows the gem stone to fall out.

However, the problem may not always lie solely with the customer. It may be inherent casting porosity in, for example, the prongs of a setting that weaken the prong. Examples of broken prongs attributable to **casting porosity** have been seen, usually resulting in gem stones falling out .This is clearly the fault of the manufacturer.

**The choice of alloy** used in a ring's manufacture can also play a part. Often the manufacture uses an alloy that is inherently soft in the annealed condition. This choice may favour his manufacturing route and ease gem setting, but it is not optimum for the customer and the rings performance in service. In some cases, the ring has a slender shank and so inherently has lower mechanical strength. With gem-set rings in particular, the ring is often made by investment (lost wax) casting, and so the metal will be in the soft condition as cast. It is not possible to work harden the metal here.

As shown in Table 2, we see most complaints with platinum and white gold gem set rings. These are usually produced by investment casting. If we look at these complaints in terms of the alloy used and its hardness (hardness equates with tensile strength too), Table 7, we find, particularly for 9ct white gold and 950 platinum alloys, many of the complaints relate to alloys that are inherently soft (Vickers hardness <100). It is generally accepted that alloys for jewellery should have a hardness of at least HV120 (moderate hardness). With platinum alloys, the platinum – 5% cobalt alloy is considered a good casting alloy and has a moderately good hardness of about HV135. Not listed is the use of platinum – 5% gold alloys which are sometimes seen in complaints11. This is also a soft alloy with a hardness of about HV90. Where soft alloys are used, then part of the blame for wear damage must lie with the manufacturer, since items should be 'fit for purpose'. It is, perhaps, not fully recognised by manufacturers that the lifestyle of its customers has changed and so they need to adapt their products to meet this change.

The problem of cracks and fractures was usually attributed to heavy knocks and so falls to the customer rather than the manufacturer, although there were examples of brittle alloys, suggesting contamination by embrittling impurities12 or a large grain size as the cause.

**GOLD ALLOYS**

| 9ct white gold | Silver % | Copper % | Nickel % | Palladium % | Zinc % | Other % | Hardness. annealed |
|---|---|---|---|---|---|---|---|
| | - | 35 | 13 -14 | - | 12 | - | Hard (2) |
| | 55 | 2 | - | - | 4.5 - 5 | - | Soft (2) |
| | 56 | 5 | - | - | - | - | soft |
| | 56 | 2.3 | - | - | 4.5 | - | soft |
| | 55 | - | - | - | - | - | soft |
| | 50 | 4 | - | - | 6 | - | soft |
| | 45 | 13 | - | - | 4.3 | - | soft |
| | 58 | 3.5 – 4.0 | - | - | - | - | Soft (2) |
| **18ct gold**** | | | | | | | |
| | 12.5 | - | - | 12.5 | - | - | Soft, (2) HV90 |
| | 14 | 1 | - | - | - | - | Soft HV85 |
| | 10 | 9 | - | 5 | - | - | hard |
| | 12.5 | 12.5 | | | | | Yellow HV150 |
| | - | 7.5 | 12 | - | 2.6 | - | hard |
| | - | 15 | 6.5 | - | 3 | - | hard |
| | 9 | 5 | - | 9 | 2 | - | moderate |
| | - | 10 | - | 12.5 | - | - | Moderate |
| | - | 14 | 5.5 | - | 5 | - | hard |
| | | | | | | | |

*These rings suffered heavy wear, were sometimes misshapen and/or had missing stones. (x) = number of items in this alloy * * white gold unless otherwise stated

Table 7 Analysis of alloys used in gem-set rings and their hardness*

**PLATINUM ALLOYS**

| | Copper % | Cobalt % | Palladium % | Ruthenium % | Other % | Hardness |
|---|---|---|---|---|---|---|
| **950 platinum** | - | - | 5 | - | - | Soft HV60 (4) |
| | 4.5 - 5 | - | - | - | - | Moderate, HV 108-120 (5) |
| | - | 5 | - | - | - | Moderate HV135 (9) |
| | - | - | 2.5 | 2.5 | - | Soft HV90 |
| | - | - | - | 4.5 - 5 | - | Moderate HV 120-130 (3) |
| | - | 1 | 4 | - | - | Soft HV75 |
| | - | 2 | 3 | - | - | Soft HV90 |
| | 1 | - | 1 | - | - | Soft HV70 |
| | - | - | -- | | 4Rh,1Ga | Hard (brittle) |
| | - | 2.5 | 1 | - | - | Soft HV85 |
| | - | - | - | - | 2.8W, 0.7Ni | Hard |

*These rings suffered heavy wear, were sometimes misshapen and/or had missing stones. (x) = number of items in this alloy

Another frequent problem is that of colour change of white golds. As discussed earlier, this is due to rhodium plating wearing off, revealing the off-white, yellowish colour of the underlying white gold alloy. Sometimes the rhodium wears away quite quickly after purchase. This suggests that rhodium plating is not of good quality and possibly applied very thinly (a 'flash' coating). Rhodium plating baths are sensitive to contamination, for example, and surface cleanliness is also important. Rhodium plating tends to become internally stressed as thickness increases, so an optimum plating thickness is about 2 -3 microns. Such coatings should last about 2-3 years of normal wear. In such cases, it is difficult to be certain whether the customer or manufacturer is at fault; on the balance of probabilities, the customer must bear some blame as often the rhodium plating on the inner surface of the shank is intact.

A related problem here is that often the customer does not know his/her white gold ring has been rhodium plated. My advice to retailers is to write on the sales receipt that the ring (or jewellery item) has been rhodium plated. That assumes, of course, that the retailer is aware the item has been rhodium plated!

**B] Other items of jewellery:** The major issue in this category was **plating problems**. As discussed earlier, most of these related to poor plating quality of gold on sterling silver, typically pinholes that allows corrosion or tarnishing of the underlying silver to progress. This is clearly a manufacturing problem.

In the case of **tarnish issues**, these were mostly on sterling silver. This suggests the customer is to blame, but it may also be a retailer/manufacturer issue if sulphur-free packaging has not been used. We should also recognise that today, there are many commercial sterling silver alloys on the market that are tarnish resistant. Should manufacturers use these newer, improved alloys? There is an argument that says they should. It is, perhaps, surprising that protective coatings are not used on normal sterling silver items, such as thin transparent oxides13.

To summarise this section, it is apparent that the blame for customer complaints can often be placed with the customer, but sometimes it is due in part or totally to the manufacturer - manufacturing errors, poor material choices and not designing the item with adequate properties to suit the application – 'fitness-for-purpose'. The jewellery designer does need to consider design from this engineering standpoint as well as from an artistic design aspect and recognise the harder demands placed on jewellery due to changing lifestyles.

## CONCLUSIONS

1. An analysis of customer complaints in the UK over the last 3 years has been carried out. We now have a better understanding of the major issues that lead to such complaints.
2. The major item of complaints is rings, particularly those set with gem stones. The problems appear to centre on white gold and platinum rings .Heavy wear and loss of shape and gem stones are the most frequent causes of complaints.
3. In many cases, the blame lies mainly with the customer and their lifestyle.
4. In some cases, the blame lies in part or totally with the manufacturer
5. It is to be hoped that this analysis serves to assist manufacturers to improve quality and hence performance of their jewellery in service with their customers.

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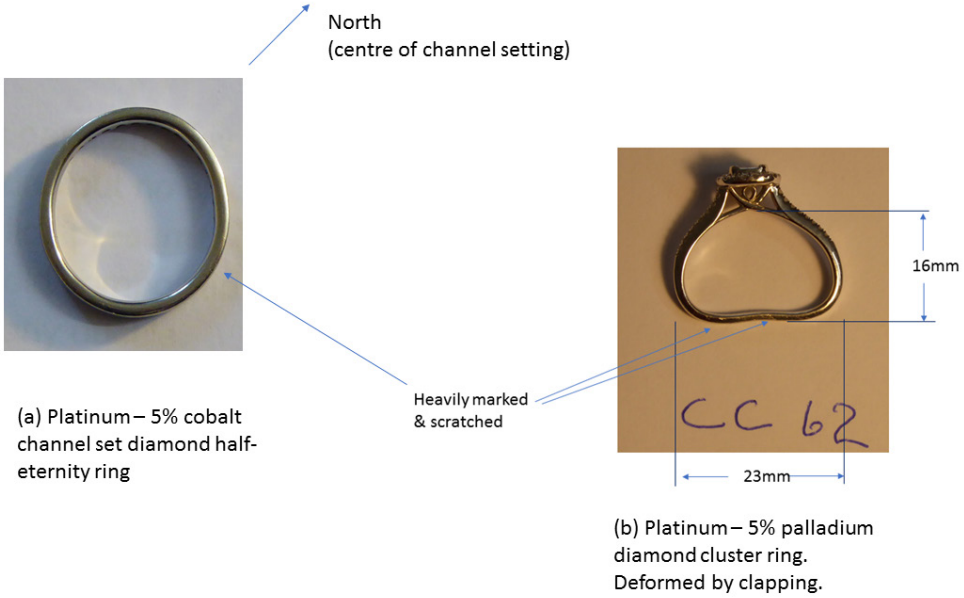


Figure 1 Typical platinum rings that are misshapen (a) Pt-5%Co channel set diamond half-eternity ring, (b) Pt – 5%Pd diamond cluster ring

**LIST OF FIGURES**