Institution: Middlesex University
Unit of Assessment: 34 Art & Design
Title of case study: Argentium Silver Project
1. Summary of the impact (indicative maximum 100 words)

Argentium, a sterling silver alloy with unique properties, has stimulated jewellers to develop designs retailing in over 1,220 high street shops in the UK alone and craft jewellery makers to extend their design practice around the world. A spin-out company from Middlesex was sold to private investors in 2008. Middlesex remains in partnership with Argentium International Ltd., and retains a board seat. The seven companies presently licensed to manufacture Argentium alloy are Legor Group, Heraeus, GSM Metals Inc, Lamet Spa, Noble Mind, Nubia and Pasavento. Route to impact was creation and protection of intellectual property, and its exploitation through a spinout company. Beneficiaries include silversmithing and craft industries, jewellery retailers, and users of Argentium Silver.

2. Underpinning research (indicative maximum 500 words)

Research at Middlesex showed that germanium possessed many properties in alloy with silver: firescale elimination; high tarnish resistance; precipitation hardening and simple heat-hardening properties; increased ductility; increased thermal and electrical resistance (making alloys suitable for welding and laser forming); and environmental advantages (associated with not having to remove, or plate over, firescale). Argentium complies with safety standard ISO 8442-7, allowing it to be used in food utensils. Other claims have been proved by subsequent research such as the following valuable characteristics for jewellery craft workers:

- Easier soldering/brazing due to the suppression of the copper oxide.
- Can be fusion and resistance welded.
- Cost savings on finishing, so there is no need to strip or plate over firestain.
- Environmental, health, and safety advantages, with no need for plating and hazardous cyanide or other stripping chemicals.
- Precipitation hardenable by heating at temperatures obtainable in a domestic oven.
- Superior ductility.
- Higher tensile strength.

(see http://www.silversmithing.com/1argentium.htm) [Accessed 14/11/13]

Underlying research was undertaken at Middlesex by Peter Johns (1971-2004) – this specific research being funded by a CRAFT/BRITE-EuRam grant (BRE20289 - BE 5721) of €200k to a TNO-led consortium including Middlesex. Research on Argentium led to grants of patent to the University. The first silver/germanium alloy patent, 'Novel Silver-based Ternary Alloy', was granted in 1994 (GB 2255348). The key breakthrough for the team's research came trough investigations on joining and bonding, specifically USA Patent No. 6,168,071 in 2001. Subsequent patents extended claims in relation to germanium silver alloy. Johns has remained a lecturer at Middlesex since 2007 while simultaneously holding the position of Research and Development Director at Argentium International Ltd. Johns was the first recipient of the Manufacturing Jewellers Society of America Innovation Award for his work on Argentium.

Research has focused on the changed conditions for working silver by silversmiths. Argentium sterling silver replaces some of the copper in the silver alloy with germanium which has the benefit of eradicating silver tarnishing (due to a reaction with sulphurous gases in the atmosphere) and firestain (reddish-purple oxidation on the surface of sterling silver when heated in the presence of oxygen). Both tarnish and firestain impose limitations on silversmith design and fabrication.

Experience with Argentium has suggested new techniques and processes in silvermithing, allowing new applications and designs in the jewellery industry, and research continues to develop applications and manufacturing methods. For example, a joint research project with

Wolverhampton University and industrial partners is being undertaken to develop direct laser sintering of Argentium Silver alloys. A collaborative project is also being undertaken with a US company, The Bell Group, to produce a precious metal clay for the jewellery craft market and a new technique for investment casting (patent GB2485374 filed 11th November 2010) is in development by the company.

Accessible introductions to Argentium are provided by videos produced by users, the inventor and the company:

http://www.youtube.com/watch?v=LcVMTeqpAs4 (Peter Johns)

http://www.youtube.com/watch?v=RcR_oj5yFgE (Ronda Coryall)

http://www.youtube.com/watch?v=RQ8N5Yopam0 (Argentium Silver)

3. References to the research (indicative maximum of six references)

1) Johns, P.G. (2001) [patent], A method of joining metals together by a diffusion process using silver/germanium alloys. USA Patent No. 6,168,071 - granted 2/1/2001. Patents are granted only after a rigorous, open, international review by industry and peer organisations, and are required to demonstrate novelty, 'non-obviousness' and application. Scrutiny includes detailed examination by professional patent examiners at national patent offices, which includes a search of 'prior art' (research) to establish the novelty and value of the contribution made by the patent. See also references 2, 3, 5.

2) Johns, P.G. (2013) [patent], Alloy for investment casting. (UK Publication Number GB 2485374, granted 25/06/2013. Currently under examination in the US).

3) Johns, P.G. (2004) [patent], Process for making finished or semi-finished articles of silver alloy comprising copper and germanium. (UK Application No. 04 12256.0 filed 2/6/2004, & UK Application No. 04 21172.8 filed 23/9/2004).

4) Harrison, C., Johns, P.G., Niedderer, K. (2006) [conference contribution] 'Exploring the creative possibilities of Argentium (TM) Sterling Silver'. In: *Proceedings of Design Research Society Conference Wonderground*. IADE: Lisbon. Design Research Society. This conference publication is of international standing and the quality of papers was established through peer panel review.

5) Johns, P.G. (2006) [patent], Silver solders or brazing alloys and their use. UK Patent No. GB2408269 - granted 22/2/2006.

6) Johns, P.G., (1997) [conference contribution] 'Fire Stain Resistant Silver Alloys'. *The Santa Fe Symposium on Jewellery Manufacturing Technology*, Albuquerque, New Mexico, USA, 18-21 May. Proceedings published by Met-Chem Research Inc. ISBN 0-931913-25-X, paper cited pp. 33-67.

4. Details of the impact (indicative maximum 750 words)

The Argentium Silver project team was led by Johns as a research project in metallurgy with specific applications in craft jewellery. The research has led to widespread use of Argentium, particularly in the jewellery industry.

(i) Routes to impact

The research resulted in international patent filings, trade-paper and authoritative trade journal citations, trade fair exhibitions, demonstrations and presentations, press coverage, academic papers, adoption of the material by significant practitioners, and business growth of a company. Of the 16 patents granted and pending in Europe, USA and further internationally, it is those connected with the joining and bonding of germanium/silver alloys that have allowed the material to be developed commercially and in craft silversmithing.

The ability to diffusion bond and weld Argentium Silver opens new avenues for the design and production of silverware and jewellery. For example, United States Patent 6,168,071 (granted 2001) protects the intellectual property covering diffusion bonding as a method of joining metals together without the addition of a solder or 'filler' welding material. Craftspersons using traditional jewellery equipment can easily perform this process with Argentium Silver.

(ii) Impact on the industry and on practice

Total tonnage of the new alloy shipped is a difficult figure to assess but we estimate about 40 tonnes of Argentium are currently being sold annually. Whilst that is still a small proportion of the total silver fabrication for jewellery and silverware globally (currently c.7000 tons per annum) this represents a significant contribution to the specialist market for a unique silver alloy. The most important market for Argentium Silver is the USA (c.3000 jewellers). Argentium is used by a wide range of US brands including Tiffany & Co, David Yurman, JC Penney, Home Shopping Channel, Walmart, Novell, Signet Group, and Eternal Jewellery.

Three of the high street retail outlets from which one can buy Argentium Silver jewellery in the UK during the reporting period are: H. Samuel with 304 stores, Ernest Jones with 180 stores, and Argos with 740 stores. Major brands, such as Kit Heath, have now committed themselves to providing Argentium products for British consumers, after 'Responding to retailer feedback both in the UK and the USA, …in order to combat the tarnishing of traditional sterling silver. This is a first for an established high street brand here in the UK and across the world. This is great news for our retailers and our consumers – for a brand already renowned for exceptional quality, the introduction of Argentium creates a truly outstanding offering for the UK market.' (http://masterjewellers.co.uk/news/404/kit-heath-and-argentium-achieve-world-first/)

However it is not through volume sales of Argentium alone that the research has made an impact on jewellery making and the jewellery industry. The Argentium Silver Guild (http://www.argentiumguild.com) was set up in January 2011 to unite a worldwide community of Argentium silversmiths and artisans. It provides a place for Argentium users to share their knowledge and experiences and to foster excellence through good practice and inspiration, and a number of Guild members and others have reported on the extent to which Argentium has enabled new practice in jewellery making. Some 49 contemporary silversmiths using Argentium, and members of the Guild, show their work at http://www.argentiumsilver.com/#!__gallery, demonstrating the range of impact on silver fabrication practice – including use of Argentium by instrument maker Landell Flutes, the adoption of Argentium in the skeuomorphic bowls of Lucian Taylor and the innovative designs of David Worcester Jewellery.

Samara James, a leading producer of high quality jewellery, notes that 'What this new trend in using this alloy for wedding and engagement rings has done is to open the doors to more research being done in the field of silver alloys so that the metal can be much better for both the jeweller to work on and the customer to wear' (http://www.samarajames.com/blog/2008/11/19/argentium-silver-better-for-engagement-and-wedding-rings [entry posted on Wednesday, November 19th, 2008 at 4:53 am, filed under 'Jewellery News']. Indeed *The Evening Standard Newspaper* described Argentium in their 'Design trends - silver' article published on 28th September 2011 as 'the new magic stuff used by many new makers' precisely because of the new possibilities discovered by craft makers. G&S Metals, one of the largest silver jewellery retailers, notes that 'Fabrication and workability characteristics are much better than standard Sterling silver, and it can be heat treated to achieve hardness approximately twice as strong as standard Sterling Silver…Argentium Silver is excellent for making durable, tarnish resistant silver products' (http://www.gsgold.com/catalogs/Argentium-May2011.pdf). In short, designers and makers in both atelier craft manufacture and jewellery retailing are readily exploiting the benefits of Argentium in their work.

5. Sources to corroborate the impact (indicative maximum of 10 references)

1. Argentium.com website and resources: http://www.argentiumsilver.com/#!__technical-resources/vstc1=silversmiths-and-artisans [Accessed 14/11/13]. Argentium gallery at: http://www.argentiumsilver.com/#!__gallery [accessed 15 May 2013].

2. Charles Allenden, 'The Argentium Revolution', 23rd June 2012, The Studio, Rio Grande's

Blog, http://riograndeblog.com/2012/07/the-argentium-revolution/ [Accessed 14/11/13]

3. 'Your Argentium – Interview with Cynthia Eid', Argentium Guild Newsletter, Issue 2, January 2012 (for evidence of craft working benefits of Argentium). The pdf document is available at: http://www.argentiumguild.com/#! newsletters [Accessed 14/11/13].

4 Eid, C. (2006). 'Road Testing Argentium Sterling'. Art Jewelry, 2(6) (for evidence of craft working benefits of Argentium). The pdf document is available at: http://www.cynthiaeid.com/images/pdfs/ArtJewlry-RoadTest.pdf [Accessed 14/11/13].

5 Ronda Coryell, twenty videos on the use of Argentium in silver jewellery making. http://www.youtube.com/user/rondacoryell/videos Total number of views: 57.843 views [Accessed 14/11/13].

6. 'Argentium Sterling', by Jeffrey Herman, article for the American Society of Silversmithing, ShopTalk section of the official website http://www.silversmithing.com/shoptalk.htm direct link is: http://www.silversmithing.com/1argentium.htm – silver smith and educator. [Accessed 14/11/13].

7 Allied Gold, official distributor for Argentium in the UK www.alliedgoldltd.com (for evidence of the wholesale reach of Argentium). [Accessed 14/11/13]