**Live Chat Record**

Customer Name: Australian Researcher

U.S. Manufacturer’s Representative: Joe

U.S. Manufacturer: [withheld]

Date: 16 August 2016

Joe has joined the conversation at 4:15am Australian time.

**Joe:** Hi, how can I help you?

**Australian Researcher:** I would like to enquire about the purity levels of your superelastic 0.5mm plate you sell. Can you tell me how pure are the samples you produce.

**Joe:** ASTM compliance

**Australian Researcher:** Not sure what ASTM compliance means. Is there a figure given as a percentage, say 100% pure for no impurities, but that is impossible to achieve. What's the ASTM compliance figure?

**Joe:** 99.5%

**Australian Researcher:** Also, do you annodize the surface of your nitinol products to give it the dark grey look?

**Joe:** No, we don't have anodizing equipment, that is a surface oxide layer we installed to provide optimal properties.

**Australian Researcher:** If the oxide layer is not put onto the surface, what's the genuine color of nitinol as you would describe it?

**Joe:** Bright silver

**Australian Researcher:** Often nitinol is described as like "dirty stainless steel" or like lead foil. In other words, it is dark grey but has the silvery component in it. It is as if a very thin film of black grease was been applied to the surface. Pure titanium is bright silver. Do you think this is right?

**Joe:** They're similar in color

**Australian Researcher:** Going back to the purity, what's the purest nitinol you can produce?

**Joe:** You've got it

**Australian Researcher:** You know the superelastic flat plate product you sell? How does one know if it is really superelastic? I mean, if I was told a material is superelastic, the picture in my mind is like rubber -- bend it by 180° and let it go, and it immediately resumes its original shape. Does your product show this level of superelasticity?

**Joe:** Depends on the bend radius

**Australian Researcher:** What's the maximum bend you can make in your superelastic nitinol 0.5mm nitinol product?

**Joe:** Approximately 10mm.

**Australian Researcher:** If the plate is at the flat position (0°), how does 10mm translate as an angle?

**Australian Researcher:** Bend radius.

**Australian Researcher:** Okay. It assumes I should be able to bend it to 180° with a 10mm bend radius in it. Correct?

**Joe:** Yes

**Australian Researcher:** Are you able to achieve those specifications with your flat plate 0.5mm nitinol products -- whether they are the superelastic version, or the other ones that become superelastic above a certain temperature (e.g., air temperature, body temperature etc.)?

**Australian Researcher:** 0.5mm is the thickness by the way. Actual length is probably like 10 cm.

**Joe:** Yes

**Australian Researcher:** I have seen sunglass frames and certain medical products such as stents to widen blood vessels that are really superelastic and made of NiTi. The purity of those exceed 99.995 per cent, which is critical to revealing the shape-memory effect. Your products do not reveal the effect even when cooled down significantly in a freezer overnight to permit truly flexible bending to different shapes before heating them or applying an electric current to re-activate the original shape. The reason: Your products are too impure at 99.5 per cent. As your products are not pure enough, I would like to seek a refund if I may. I have bought two nitinol products and these don't meet the specifications I require.

**Joe:** The purity is plenty good enough for the shape memory effect. The superelastic sheet needs to be chilled below -10C before martensite begins to form

**Australian Researcher:** Just to let you know, I have also purchased another product called the "Miracle Spoon" many years ago. The shape-memory effect shown by this product is far more significant than yours. You can cool it down to room temperature, bend it to 180°, dunk it into a cup of hot water, and the spoon comes straight immediately. I cannot achieve this with your Air Temperature product. Your Superelastic product is rated as activating the shape-memory response at 5°C, which means if it is pure enough, it should be possible to make the alloy very flexible to bend by more than 180°C at say 2 or 3°C or even closer to the 5°C. -10°C is too great and reveals 99.5 per cent is too impure. Just alone on the Air Temperature product, chilling it to below 0°C should automatically make it flexible to bend. It doesn't. This tells me the temperature difference from austenite to martensite phases is too great. It goes back to the purity issue -- yours are just not pure enough.

**Joe:** This is because of a few reasons: first is the existence of sharp thermal peaks rather than broad, overlapping peaks, second is because it is NiTi rather than any of the other derivatives which have lower hysteresis

**Australian Researcher:** Still, with NiTi, the thermal range for activating the shape-memory response is known to be sharp when moving from Ms to As temperatures. And that can only be achieved with high purity. At 99.5%, you can't do it. Thermal range is too broad (or as you stated, having overlapping sharp thermal peaks). There is really only one sharp thermal peak I should see.

**Joe:** Actually, you should see two, the spoons exhibit broad peaks which are overlapping, making them appear to be lower hysteresis

**Australian Researcher:** Yes, one is the cooling transformation range when it reaches the critical temperature known as Ms for turning to the martensite phase (Crystalline structure 1), and the other is the heating transformation range at around As for turning to the austenite phase (Crystalline structure 2). At a purity of 100% (if theoretically achievable), the two transformation peaks become very sharp, and the difference in the As and Ms temperature are virtually one and the same thing. Of course, this is not yet achievable in reality. However, at 99.995%, you can make the temperature differentials for producing the shape-memory effect and hence the transformation to the different crystalline structure around the As and Ms points extremely small in NiTi. But it has to be highly pure. So if I bend NiTi in the cool phase, as soon as I reach very close to the As temperature, the movement should already be very distinctive. Hit the As temperature, and the movement is almost instant and with significant force. I can't see any of this kind of movement in your products. Reason: 99.5% purity just won't cut the mustard over here for the research work that I do.

**Joe:** If our ASTM material is not pure enough for your application, you can return any unaltered pieces for a refund

**Australian Researcher:** Thank you. I will return the products to you (no alterations made, other than the attempt I made to cool them down in a freezer).

**Australian Researcher:** Just one more question. I believe it is possible to request from your NiTi manufacturer certain products that meet certain specifications. Apart from shapes that one could ask the manufacturer to make, can I also ask your manufacturer to raise the purity levels to a much higher level? Or is your manufacturer producing only 99.5% nitinol as the best it can make? If it is the latter, do you known of other manufacturers who can get it to the 99.995% range (apart from a local university's metallurgical labs)?

**Joe:** Including local labs (Harvard & MIT) I am not aware of any labs that supply better than 3 nines of purity

**Australian Researcher:** Thank you. When I send back the samples, who within your organization should I address it to for the refund to be processed?

**Joe:** Just write Attn: Returns. And include a copy of your order information

**Australian Researcher:** Will do. And thanks again. I appreciate your assistance today. Bye.