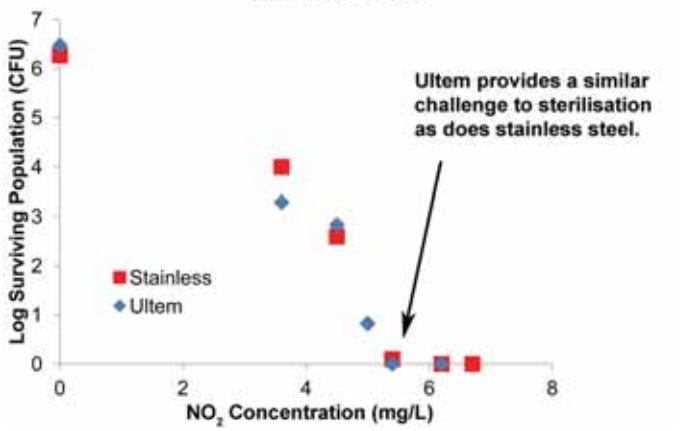
Room Temperature Sterilisation of Plastic Medical Devices with Nitrogen Dioxide

Nitrogen dioxide (NO_2) sterilisation is a new process. First FDA approval of NO_2-sterilised devices is expected in the first quarter of 2013. The developer, USA-based Noxilizer, describes plus points as: room temperature processing at ambient and low pressures; vacuum processing for faster sterilisation; low concentrations required; short processing cycles; room temperature sterilant storage; and similar validation and control methods to traditional sterilisation. Dr Evan Goulet of Noxilizer discusses applications of NO_2 in polyetherimide, silicone rubber and cyclic olefin copolymers (COCs).

Polyetherimide (Ultem), silicone rubber, and cyclic olefin copolymers (COCs) are used in devices because of their desirable properties and relatively good biocompatibility. The NO_2 sterilisation process maintains these properties while providing rapid and effective sterilisation of a wide range of microorganisms.

Ultem's characteristics include chemical and temperature resistance, high strength and durability. It provides a similar challenge to NO_2 sterilisation as does stainless steel. This is evident in figure 1, which shows the reduction of biological indicator (BI) population on both stainless steel and Ultem as the NO_2 concentration in the chamber is increased and exposure time is held constant.

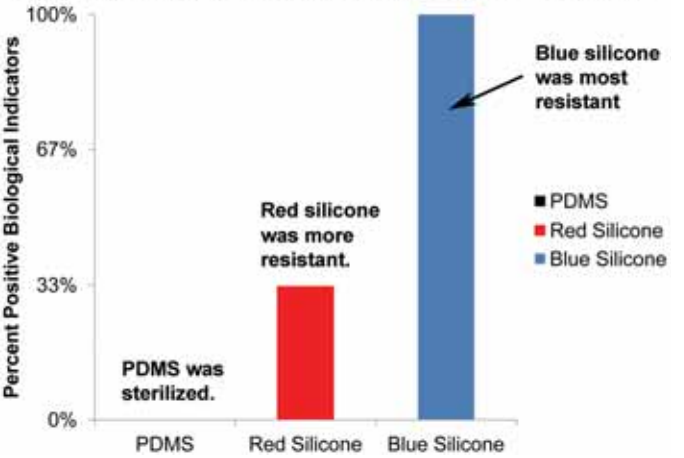
Figure 1: NO_2 Sterilisation of Ultem: Compared to Stainless Steel



In order to derive these results, coupons of Ultem and stainless steel were inoculated with spores of the bacterium *Geobacillus stearothermophilus* and exposed to the NO_2 sterilisation process. Stainless steel is a typical carrier material for BIs in many sterilisation processes, including NO_2, due to its resistance to reaction with the sterilant. Reactions between the sterilant and the carrier material can inhibit lethality, and one can see from the rate of lethality there is little interaction between the Ultem and the NO_2. Ultem coupons were also exposed to 50 NO_2 sterilisation cycles, and there were no observed changes in materials properties as measured by tactility, hardness, and surface finish.

Pure silicone rubber (polydimethylsiloxaqne, or PDMS) exhibits a challenge to NO_2 sterilisation that is similar to that of Ultem or stainless steel. It is relatively inert in terms of reactivity with the sterilant. However, additives are often used in silicone to impart colour or improved mechanical properties. These additives can increase the challenge to sterilisation that is presented by the silicone rubber, as can be seen in figure 2. Red silicone rubber (o-ring material) and blue silicone rubber (cable sheath material) were compared to PDMS. One can see that the PDMS carriers were sterilised, while 33% of the red silicone carriers and 100% of the blue silicone carriers were positive for bacterial growth after the cycle. The difference in response of the silicone materials was due to the additives in the different formulations.

Figure 2: Effects of Additives on Sterilisation of Silicone



These results indicate that the coloured materials require a different set of cycle parameters than PDMS. This indicates the importance of individually screening materials and devices to determine the appropriate cycle parameters to ensure sterilisation in the most challenging location on the devices.

Sterilisation of COCs proceeds rapidly, similar to stainless steel, due to the inert nature of the polymer with respect to the NO_2 sterilant. COC components remain clear with no colour change after exposure to the NO_2 sterilisation process. Additionally, the NO_2 gas does not permeate the COC material during the sterilisation cycle, which allows for rapid aeration of the sterilant. This means that residuals from the sterilisation cycle are low. When COC syringe barrels that have been exposed to the Noxilizer sterilisation process are filled with ASTM Class I water, the water remains within the standard limits of "water for injection" when analysed for sterilant residuals.