

Size Determination & Visualisation of Wear Debris from Orthopaedic Implants

Introduction

NanoSight instruments can visualise and rapidly and accurately size wear debris in liquid suspension produced from a range of orthopaedic implants.

Background

Characterising the size and quantity of wear debris produced from an orthopaedic implant is of importance when determining the biocompatibility and longevity of the implant.

The production and size of wear debris can influence factors such as:

- Hypersensitivity
- Aseptic loosening of the implant and associated osteolysis
- Systemic distribution and accumulation of implant debris
- 3rd party degradation of articulating surfaces
- Bioavailability and bioreactivity of metallic species
- Design and choice of material for a specific implant

The Technique

The technique looks at the light scattered from individual nanoparticles as they move under Brownian motion in the path of a laser beam.

The speed at which the particles move under Brownian motion is related to particle size, temperature and solvent viscosity. With knowledge of the temperature and solvent viscosity, particle size can be directly calculated.

As the technique looks at individual nanoparticles and sizes them on a particle by particle basis, inherent weakness in techniques such as DLS (Dynamic Light Scattering), or PCS (Photo-correlation Spectroscopy), which produce an average particle size, are overcome. The technique complements Electron Microscopy as it looks at the sample in its natural, unprepared state. Analysis time takes only 3-5 minutes from sample preparation to the particle size distribution result.

As the technique visualises individual particles it can provide an estimate of the particle concentration within a sample. This allows the user to not only determine particle size but also relative concentrations within specific size classes.

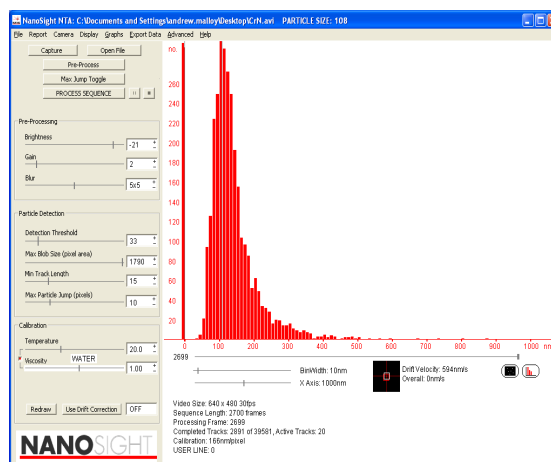


Figure 1: Particle size distribution produced from a metal on metal CrN prosthesis.

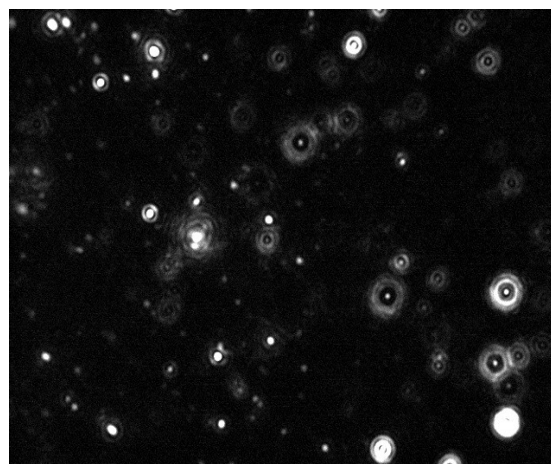


Figure 2: Image of CrN wear debris produced by the NanoSight system. The polydispersity of the sample can be clearly seen with some particles scattering more intensely than others.



Sample Preparation

Samples are prepared to remove the protein content from the synthetic/natural synovial fluid. Failure to remove the proteinaceous content would increase the signal to noise ratio but would not prevent analysis.

Polyethylene samples are treated for 1-2 days in KOH followed by solvent extraction using a chloroform/methanol mix. Hot enzymatic digestion is used to isolate metallic particles.

In general, the technique requires sample dilution to approximately 10^9 particles/ml. From this, a sample of less than 500 μ l is taken and injected into the viewing unit.

Key Features

- Particles can be measured in natural state (without drying/vacuum)
- Greater ability to size polydisperse samples due to the insensitivity to intensity (associated with light scattering techniques)
- Small sample volume
- Low cost of unit
- Visualisation of individual particles without any pretreatment such as labelling
- Straight forward and rapid technique
- Allows the study of time-based changes, such as agglomeration/ stability
- Accurate particle sizing from 10 nm— 1000 nm

Contact Details

For further information, contact NanoSight or your local distributor, listed at www.nanosight.com

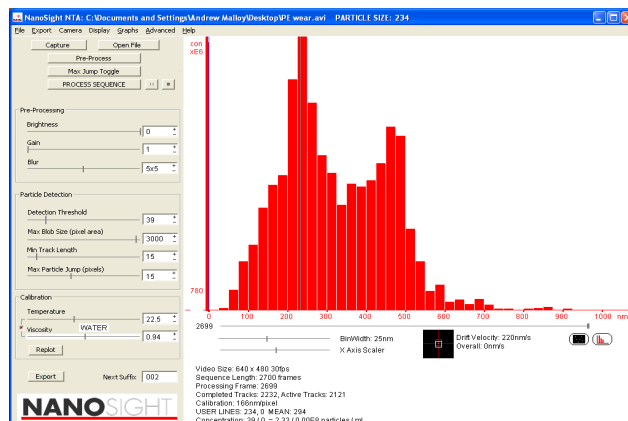


Figure 3. Particle size distribution produced from a polyethylene (PE) prosthesis.

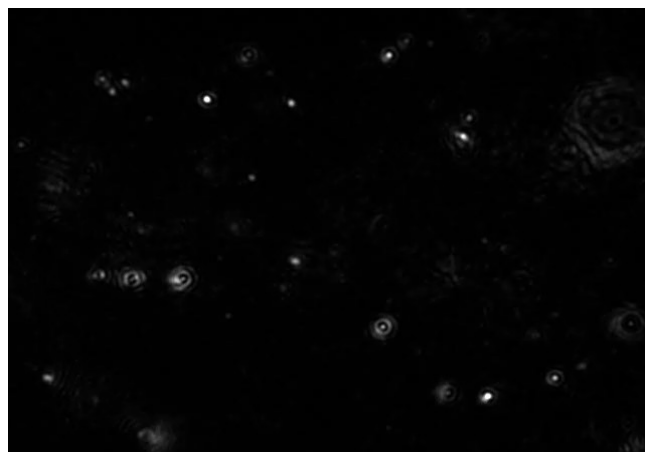


Figure 4: Image of PE wear debris as produced by the NanoSight system.

