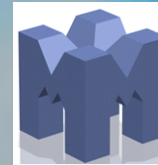




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MANUFACTURING  
METROLOGY TEAM

# Research in metrology for AM in Nottingham

Professor Richard Leach

Manufacturing Metrology Team, Faculty of Engineering



# Additive manufacturing at Nottingham

## Polymer Jetting

### Metallic Powder



### Polymer Powder



### Polymer Filament



### Nano-scale





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# Metrology



# Something missing?

- With AM we can make some highly-complex components and even assemblies
- But what about QUALITY?
- So far, most people involved in AM have never heard of the word TOLERANCE
- All mature production processes have suitable quality systems in place
- Why should this be different for AM?



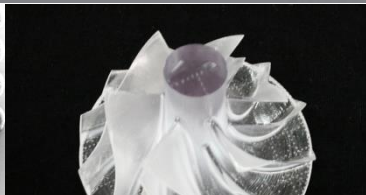
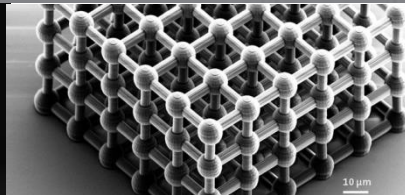
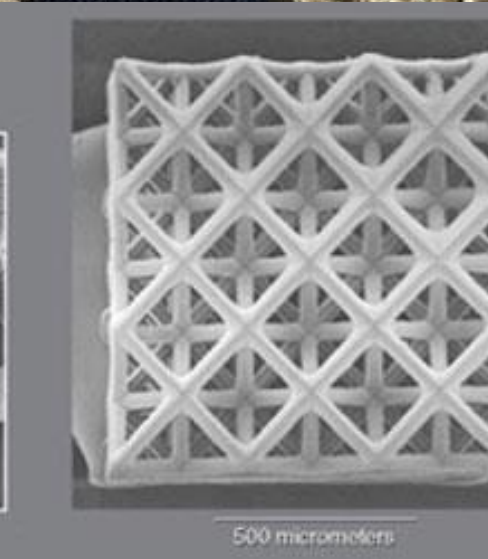
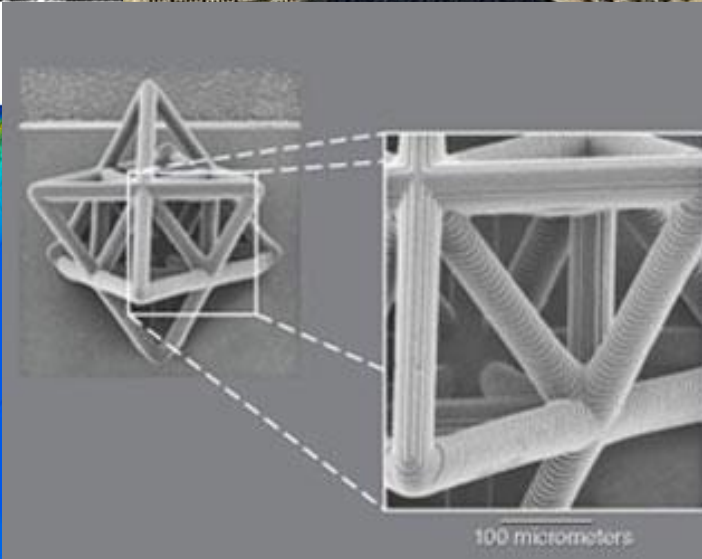
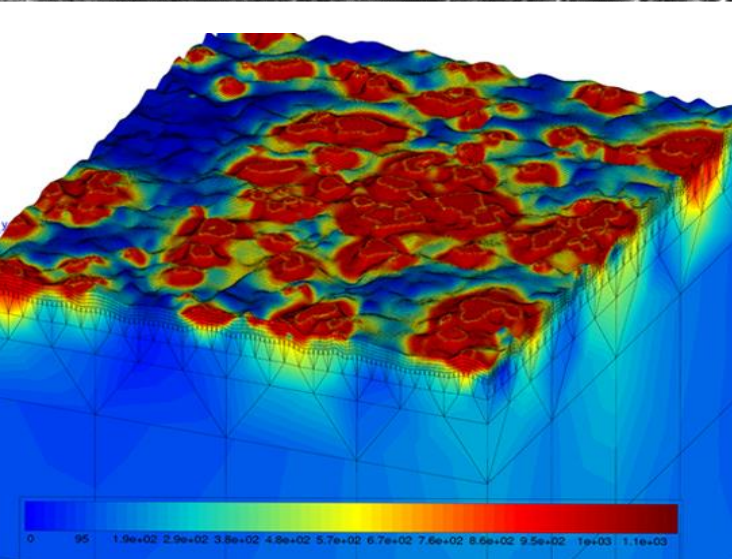
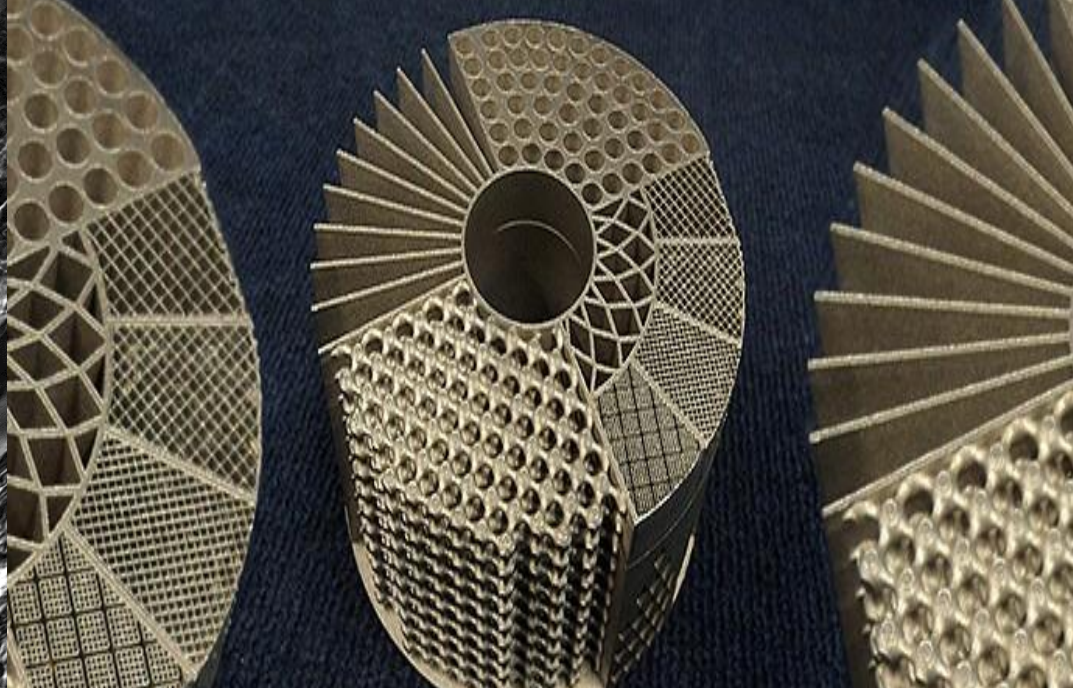
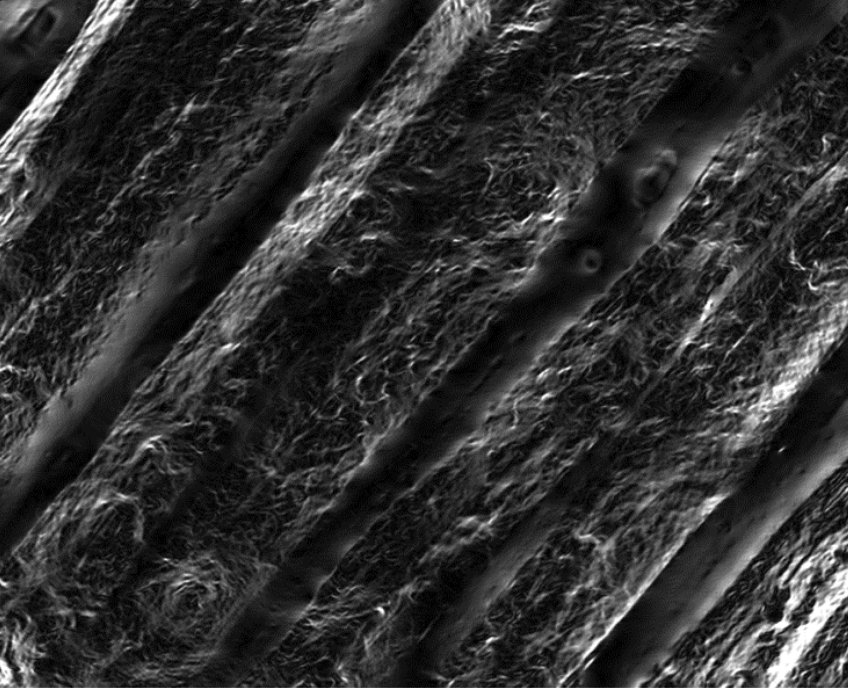
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# Metrology for Additive Manufacturing





# Why is AM an issue for metrology?





# Why is AM an issue for metrology?

- With almost infinite design freedom, comes almost infinitely complex shapes to measure!
- Complex surface texture – very high slope angles
- Huge range of materials – plastics, metals, ceramics, ... growing daily
- The need for speed!





# First – publish the review papers

- Leach R K 2016 Metrology for additive manufacturing *Meas. Contrl.* **49** 132-153
- Townsend A, Senin N, Blunt L, Leach R K, Taylor J Surface texture metrology for metal additive manufacturing: a review *Precis. Eng.* **46** 34-47
- Thompson A, Maskery I, Leach R K 2016 X-ray computed tomography for additive manufacturing: a review *Meas. Sci. Technol.* **27** 072001
- Stavroulakis P I, Leach R K 2016 Review of post-process optical form metrology for industrial-grade metal additive manufactured parts *Rev. Sci. Instrum.* **87** 041101
- Everton S K, Hirsch M, Stavroulakis P, Leach R K, Clare A T 2015 Review of in-situ process monitoring and in-situ metrology for additive manufacturing *Materials and Design* **95** 431-445



# AM Metrology

## Research at Nottingham

- Develop new structured light techniques for AM component metrology
- Enhance X-ray computed tomography for internal features
- Develop techniques to map the surface generation mechanisms in AM using surface texture metrology
- To investigate in-process metrology for AM (OCT, acoustic, structured light, scattering)
- Integrate IRM principles throughout, i.e. increasing dynamic range of sensors and reducing measurement times