Summary of SAnPM 2019

The 1st Symposium on Acoustics of Nanoporous Materials (SAnPM) took place on the 19th of February of 2019 at Salford University, United Kingdom.

The symposium was fully sponsored by the UK Acoustics Network (www.acoustics.ac.uk) and aimed at bringing together acousticians, chemists, material scientists, physicists, mathematicians, engineers and entrepreneurs with interest in the emerging field of acoustics of nanoporous materials and methods for their characterisation, synthesis, and modelling.

Thirty delegates from academia and thirteen from industry attended to the symposium. These came from the UK, France, Italy, Czech Republic, USA, Canada and China.

The programme of the symposium included 5 keynote talks, 10 invited talks, two informal discussion panels, and a poster session. A broad range of topics were covered, which provided different perspectives and views on the transversal role of acoustics in fundamental and applied research on nanoporous materials. In general, the speakers made their presentations accessible and the feedback provided by the attendees revealed that the talks were assessed as of high quality, didactic and stimulating.

The symposium began with a Welcome Speech given by Prof. R. Stephenson, Deputy Vice-Chancellor of Salford University. This was followed by Dr. R. Venegas' introductory keynote that discussed acoustics of hierarchical nanoporous materials including the challenges associated. Prof. S. Brandani's keynote provided a general overview of

mass transport and measurement techniques for diffusion in micropores, together with stressing the potential of using acoustic waves for measuring diffusion in nanoporous materials. Prof. S. James gave a keynote on mechano-chemical synthesis of nanoporous materials and liquids with permanent microporosity. Dr. B. Coasne's keynote addressed the key role of fluid adsorption and transport in acoustics of nanoporous media and evidenced the use of acoustic emission as a tool for monitoring nanoporous membranes. Prof. Tan's keynote discussed the mechanical properties of nanoporous materials with emphasis on the effects of anisotropy and collective dynamics.

The keynotes were followed by an informal discussion panel where some possible topics for collaboration were identified. These include 1. Using acoustics for probing mechanical properties of porous adsorbents, which give an opportunity of rapid screening of small samples, 2. Developing acoustical methods for in situ characterisation of fluid adsorption and transport in porous media, 3. Exploitation of unusual acoustical properties of porous adsorbents and manufacturing materials with optimal microstructure, 4. Acoustical characterisation of heterogeneous catalysts. It has been emphasised that new theoretical methods (e.g. new homogenisation techniques) ad new characterisation methods need to be developed to investigate the acoustical properties of materials and composites with hierarchical pore microstructure, fluids in confined environments and, new exotic materials (e.g. porous liquids).

The invited talks session started by Dr. F.-X. Bécot who presented experimental characterisation of porous materials and highlighted the need for novel characterisation methods that account for the particularities of nanoporous materials. Prof. J. Yang's talk addressed the problem of measuring the acoustical properties of nanoporous materials that are not available in large quantities via introducing a novel impedance tube-based measurement method. Prof. W. Parnell's presentation highlighted the importance of the modelling of thermo-viscous losses in narrow channels saturated with different fluids. Dr. O. Umnova's talk discussed the acoustical properties of activated carbon-based fibrous materials and stated conditions that optimise their sound absorptive behaviour. J. Coakley presented applications of nanoporous materials in audio, acoustics and dynamics and gave a highly-praised demonstration that evidenced the atypical effective compliance of cavities partially filled with activated carbon.

The second part the invited talks session was started by Dr. F. Pérez-Cota who presented his work on imaging with Gigahertz ultrasonics, which provides means to measure material properties in biology at single-cell level. Dr. G. Gor's talk discussed the use of ultrasonic

waves for characterising nanoporous materials and emphasised the effect of confinement on the pore-size dependent compressibility. Dr. V. Pinfield presented her work on ultrasonic characterisation and properties of nano- and micro-particle suspensions. Dr. M. Nori's talk discussed the assessment of adsorption processes in nanoporous media with the acoustic frequency response technique. Dr. M. Conte's presentation highlighted the need for novel pore size determination methods for nanoporous materials used in catalysis applications and discussed a promising acoustic-based method for this purpose.

Six contributions were presented in the poster session. Dr. Sun presented his work on mechanical energy dissipation via liquid intrusion into metal-organic frameworks. H. Begum's poster investigated the acoustical and mechanical properties of nanoporous aerogel-based materials. Dr. King presented a work on the sound absorbing properties of thermoplastic nanofibres and an application to noise reduction in drones. A. Hurrel's presented his work on how nanofibrous membranes influence the acoustic absorption of porous media. Dr. V. Pinfield presented a poster on the effective dynamic properties of random suspension of spherical solid particles in a viscous fluid. E. Kalavsky's contribution investigated a metamaterial structure with nanoporous sorptive materials for low frequency sound absorption.

These and other presentations have identified a range of specific challenges and opportunities for future collaboration, some of which are beginning to become explored:
1. Need for simple non-sampling acoustic composition detectors for binary mixtures.
2. Need for techniques which bridge the gap between microscopic and macroscopic properties of diffusion of nanopores.
3. New methods for synthesis by ultrasound.

4. Use of acoustics for the analysis of rheological changes in nano-porous media.
5. Use of acoustic emission to monitor nanoporous membranes.
6. Developing new analytical solutions for complex nanopore geometries.
7. New method of detection and modelling of nano-particle aggregation in porous media.
8. Better understanding the physics of/losses mechanisms in porous media particularly in complex fluids.
9. Better links between mathematics and experiments.
10. Modelling and characterisation of hierarchical nanoporous media under different operational conditions with fewer input parameter models.
11. Application of gigahertz sound to nanoporous media.
12. Understanding better microporous material characterisation effect and pore geometry deforming during characterisation.
13. Nanoporous media manufacturing at low cost.
14. Use of pore size dependence and nano-confinement for material characterisation.
15. Use of sound to determine the adsorption and diffusion coefficients.

The symposium concluded with an informal discussion on opportunities for collaboration, future directions, and possible tangible outcomes of this event. There were good suggestions related to survey articles and to the creation of general statements about the importance of this subject leading to new grant proposals. Kirill Horoshenkov described the opportunities for developing new collaborations which exist within the UK Acoustics Network.

An electronic questionnaire was sent to all the participants. 24 people responded providing a largely positive feedback. 96% agreed that this event met their expectations. 92% of the responded participants suggested to run this event next year. 67% acknowledged that they would be developing new networking opportunities from this event. The use of electronic badges, provided by Blendology, was instrumental to connect people. For example, an average of 11 unique connections per attendee was recorded.

The audience agreed that a diverse range of subjects were covered at this symposium: acoustics, chemistry and materials; that the presenters were very well chosen; a very informative and valuable overview of nanoporous materials from a variety of perspectives was given.

It was also widely recognised by the audience that this symposium was a successful event, primarily because it facilitated the gathering of people with a common interest on nanoporous materials but who work in different fields (e.g. acoustics, chemistry, material science, mathematics, statistical physics, etc.). In general, we can state that this symposium was in the best spirit of the EPSRC UK Acoustics Network

The Organising Committee
Dr. R. Venegas, Dr. O. Umnova, E. Kalavsky & Prof. K. Horoshenkov