What's up in nanomedicine?

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The publications discussed here are selected exemplarily among many other excellent publications. This also applies to the mentioned conferences or events. We very much appreciate your feedback on the column, suggestions for topics to be argued about, or other related information. As was already stated the purpose of this column is to present novel and significant developments within the multidisciplinary field of nanomedicine or significant developments in other scientific areas.

Publication digest

Aerosol-photopolymerization: nanostructured polymeric particles

The shape of nanoparticles for drug delivery is very important with respect to the performance of the drug delivery process. Many methods for the manufacturing of drug-loaded polymeric nanoparticles already exist. Examples are interfacial polymerization, solvent displacement, and emulsion polymerization [1]. Akgün and coworkers [2] already developed a method for the manufacturing of spherical nanoparticles. This method is called aerosol photopolymerization and was further developed to produce non-spherical polymer particles (nanocaps) and nanostructure porous polymer particles (mosaic particles) [3].

The monomers used were methylmethacrylate (MMA) and butyl acrylate (BA). Irgacure 907 and 1,6 hexadiol diacrylate where used as the photo-initiator and crosslinker, respectively. For the generation of the nanocaps, glycerol and a volatile solvent were also required. The setup consists of an aerosol generator for the generation of monomer droplets and a photoreactor for the polymerization of these droplets. Both particles were characterised by using scanning electron microscopy (SEM), transmission electron microscopy (TEM) and were investigated regarding size distribution and surface area. They further successfully generated multifunctional nanoparticles of both the nanocaps and the mosaic particles by in situ hybridization with zinc oxide nanoparticles. The photoinitiator could even be completely substituted by the zinc oxide nanoparticles in the case of the hybrid mosaic particles. The investigators also generated caffeine-loaded nanocaps and mosaic particles and investigated the release of caffeine in comparison with caffeine-loaded spherical nanoparticles, which were manufactured with the same method. The presented method enables the incorporation of molecularly dissolved compounds or inorganic nanoparticles into nanostructured polymeric particles.

Virus and nanoparticle sensing

Even though the system was already presented in an earlier publication [4], I would like to emphasize the following method, which is unique for the characterization of biological or functionalized synthetic nanoparticles. Daaboul and coworkers [5] used a nanoparticle microscopy system called the Single Particle Interferometric Reflectance Imaging Sensor (SP-IRIS) for the combination of single particle counting and multiplexed affinity-based capture. The system exists of a microscope with LED illumination, 50× objective (0.8 numerical aperture). For imaging a CCD camera is used. The sensor surface is made of a Si/SiO_2 layer coated with a nonfouling copolymer. On top of the copolymer, monoclonal antibodies were bound. The wide-field imaging technique enables the detection of single nanoparticles or viruses with size dimensions of 60–200 nm that are bound to the surface of the sensor. To demonstrate the capabilities of this system, both capture

and size targets were tested. A set of virions that vary in glycoprotein expression profiles as well in sizes was selected; replication-competent wild type and defective vesicular stomatitis virus (VSV) and Marburg- and Ebola-pseudotyped VSV. Genomes of recombinant viruses that contained Ebola or Marburg virus glycoproteins were extended by ~500 bp by the insertion of genes for glycoproteins. The extension of these genomes resulted in an increased length of the virus itself, as was also shown in a cryo-electron microscopy study of VSV structures [6, 7]. Antibodies specific for glycoproteins of the above-mentioned viruses were deposited on the layered substrates. They successfully demonstrated that size discrimination of the imaged nanoparticles enables the differentiation between the different genome lengths. A detection limit of 5×10^3 for the Ebola and Marburg VSV pseudotypes was achieved.

Self-folding single cell grippers

A new challenge for single cell capture and anaysis are the bioresorbable, biocompatible and self-curling cell grippers developed by Malachowski et al. [8]. The grippers can be manufactured such that they are arrayed or can be released and function as untethered or free floating tools. The arrays might be used, for example, as a single cell in vivo analytical assay device. The manufacturing of the grippers was done by using e-beam evaporation of thin films of SiO and SiO_2. The actuator hinge is a pre-stressed SiO/SiO_2 bilayer, while the rigid elements are SiO. When the sacrificial layer on the grippers is dissolved, they close and enable the capturing of cells. Each gripper hinge has a radius of curvature that is related to the mechanical properties of the used materials, the thickness of the film and the residual stress of each layer within the pre-stressed layer. The investigators suggested that a thermoresponsive trigger layer might also be molded on top of the grippers. Various sizes of grippers were manufactured and investigated, ranging from 10 to 70 μm. The capability of the smaller grippers was demonstrated by capturing red blood cells from a beagle blood sample. Here, the grippers were released from the substrate upon release of the arms. This showed the potential for capturing cells in a solution. The open gripper size was about 4–5 times the size of a red blood cell, 35 μm and 6–8 μm, respectively. In another experiment, mouse fibroblast cells in warm culture media were pipetted on top of open grippers. Within 2–6 h of incubation, a slow etching action of the sacrificial layer resulted in the closure of the gripper arms. The cells remained viable as was showed by the investigators by performing a live/dead assay. The best observed yield of the array was 48% filled grippers of an area with approximately 75 grippers.

Upcoming events

- **The European Alliance for Personalized Medicine (EAPM)** will hold the 9th and 10th of September conferences in Brussels (Belgium). Even though there is nothing directly related to nanomedicine during these conferences, personalized medicine is one of our aims as presented by Prof. Patrick Hunziker in his Editorial [9]. The goal of this event is to inform the policy makers about how personalized medicine might improve healthcare and about the needs of modern day patients. These conferences are interesting for leading experts in this area, science, academic and researchers, healthcare professionals and industry. Policy makers and legislators will be present during the events.
- **The European Technology Platform (ETP) Nanomedicine Annual Event and General Assembly 2014** will be held the 15th and 16th of October in San Sebastian (Spain). The aim of this year is to provide details on the practical implementation of the recommendations of the ETP for a strong European translational nanomedicine sector. In addition, future priorities for nanomedical researchers and innovations until 2020 will be revealed. This event is the place to be for all scientists in the nanomedicine field but also for industry, policy makers and care opinion leaders.
- **The BioNanoTech Montreux** (Switzerland) taking place 17–19 November 2014. This conference is for experts in nanotechnology with an emphasis on medical, chemical and biological applications. Topics include for example: nanomedicine, point of care devices, nanofluidics, clinical applications of nanotechnology, novel handling techniques for single cell platforms, single cell imaging. This conference is ideal for exchanging ideas and developing new projects.

A final note, the **Impressions of the CLINAM Summit 2014**, held in Basel (Switzerland) June 23–25, can be found at:
http://www.i-net.ch/impressions-of-the-clinam-2014-june-23-25-in-basel/?context=nano

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