Controlling the Toxicity of Zinc oxide nanowires (ZnONWs)

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The Zinc oxide (ZnO) nanomaterials market is worth a couple of billions of dollars per year, and is expected to increase by 20% in 2022, due to their unique characteristics. These properties include anti-microbial activity, piezoelectricity and a direct wide band gap which make ZnO nanomaterials very attractive for a wide range of applications. For example ZnO nanoparticles (ZnONPs) can be found in cosmetics and paints. The shape of ZnO nanowires (ZnONWs) leads to improved piezoelectrical activity, hence they are great potential candidates for energy harvesters, sensors, wearable electronics and biomedical applications. Because of the applications of ZnONWs, direct exposure to human and skin is inevitable; therefore, their toxicity needs to be investigated. The current project was constructed to examine the toxicity of ZnONWs *in vitro* (skin cells) and correlate potential toxicity to physicochemical characterization such as size and surface properties. The synthesis of ZnONWs was done via hydrothermal method, with Na_2CO_3 and ZnCl2 at 140°C for 4-6hrs. SEM and TEM were employed to investigate their surface and size. The toxicity of ZnONPs and $ZnCl_2$ (as a zinc ion model) compared with ZnONWs. Both physicochemical characterization and toxicity studies confirmed that ZnONWs are toxic *in vitro* at 20 µg/mL and above (up to 160 µg/mL zinc equivalent). Additionally, dissolutions studies showed the ZnONWs toxicity to be ion related (zinc dissolution) since they had the same toxic effect as ZnONPs and $ZnCl_2$. In order to try to control the dissolution (and consequently the toxicity) of ZnONWs, a TiO_2 shell was deposited via Atomic layer deposition (ALD) and characterized with SEM and TEM. Future plans involve testing the TiO_2 coated ZnONWs in skin cells and co-culture skin model with 2 different cells in air liquid interface (ALI) conditions for more realistic skin exposure scenarios.

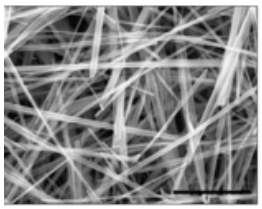

Figure 1: SEM of ZnONWs via hydrothermal growth method

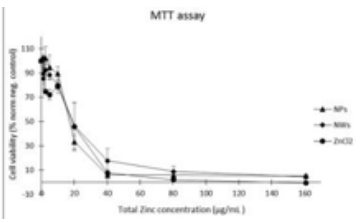

Figure 2: MTT cytotoxicity assay used for cell viability after treatments. ±SD mean