Bath Monash Global PhD Programme in Sustainable & Circular Technologies

Project Title:	Functionalised plant-based substrates for protein detection in urine using vibrational spectroscopy
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Supervisors at Bath (Host institution)	Dr Paul De Bank Prof. Karen Edler
Indicative period at Bath	Mid 2024-End 2025

Project Summary (to include a brief description of the relevance to sustainable & circular technologies)

Kidney disease in diabetes is a major and growing health problem in Australia and the UK. Diabetes is the most common cause of kidney failure requiring costly dialysis or transplantation. Increased levels of albumin in the urine is the earliest sign of chronic kidney disease (CKD) and can provide important information about kidney health in diabetes. Early detection and monitoring are pivotal to prevent kidney failure and cardiovascular problems as well as reducing mortality.

Currently used methods such as (dipstick) or urinary albumin/creatinine measurements have significant shortcomings. They require visits to a GP or laboratory; they are costly and take time and there is often a delay in obtaining the results. Dipsticks are not reliable and have low sensitivity and produce plastic and paper wastage. Current guidelines suggest performing albumin measurements in at risk diabetic patients twice yearly.

The project aims to apply an inexpensive matchbox size, handheld near-infrared spectrometer to measure urinary proteins localized on plant based functionalised substrates. Initially a multivariate regression model will be built to quantify protein and establish the limit of detection in water before moving onto spiked urine and finally predicting albumin levels in patient samples.

The final device would have the potential to make the screening for urinary albumin much more accessible and environmentally friendly. The matchbox sized device with a plant-based substrate has major advantages: it is much cheaper and faster, delivers results immediately and provides remote and de-centralised access, is safer as it avoids direct contact with urine and allows to monitor treatment effects in a cost-effective and safe manner, facilitating risk stratification and promoting the advent of personalised medicine. This device can be used in remote areas including in the Indigenous population, which has the highest risk for CKD world-wide and will allow for safe and virtual screening of pregnant diabetic women for early kidney disease.