Robert Edgington, 1st Feb – 17th July 2010. r.j.edgington@gmail.com

On the 1st February 2010 I set out from London to join Professor Hiroshi Kawarada's laboratory in the Department of Electronic and Photonic Systems of Waseda University, Tokyo. For the next 5 and-a-half months I undertook a research proposal to develop a novel diamond-based biosensor that promised to show world-class sensitivity and durability. The project consisted of two main parts; firstly, the difficult task of growing a 1nm thick layer of exceptionally conductive boron doped diamond, and secondly, turning this conductive channel into an FET type biosensor for the detection of cancer marker proteins and cancerous DNA sequences.

Currently diamond FET biosensors show some of the best results for detecting biomolecules via electrical methods, however the conductive surface channel of diamond used in these devices (which is induced by a surface functionalisation of hydrogen) is chemically unstable. Our research aimed to replace this conductive channel with a more durable, electrically superior and more biologically versatile conductive channel by doping diamond with boron via a method called delta doping. Delta doping is where diamond is densely and sharply doped with a 1nm layer of boron, which avoids the detrimental effects upon the material's electrical characteristics caused by the bulk doping of diamond. The delta-doped channel gives a greater chemical stability than hydrogenated diamond, and leaves the surface free for further functionalisation and bio-tailoring. The difficulty arises in that doping diamond in such layers must be done with the relatively blunt technique of chemical vapour deposition and not MBE, and after decades of trying, the diamond community has failed to achieve the correct recipe for such a doping. I spent the first few months devising a recipe to grow these delta-doped layers, and spent the rest of my time fabricating these layers into highly sensitive biosensors.

Before I left for Japan I spoke with a friend who had just spent 8 months in Tokyo and he had some advice. He told me that 3 weeks in you'll be very overwhelmed and will just want to go home, but by the end you won't want to leave. For me he got it spot on. My tips for living there: get family over, do as the Romans do, don’t stay in your room and eat whatever is put in front of you with a big smile. Don't underestimate that last one. Working in Japan was blissful, there is lots of equipment and technicians are top-class. Everyone is incredibly helpful and I got about 1 year's work done in 5 months, but watch out you don't ask for too much help! The legends of Japanese working hours are true (there was a sleeping bag in the lab) but it doesn't feel like it because everyone is in the same boat. Make the most of your weekends, see Japan, and you'll have an unforgettable experience.