



JSPS Short term 'Invitation Fellowship' (July/Aug 2016)

Dr. Iain Crowe

The University of Manchester, UK

Hosted by NIMS, Japan

Background: Host Institute...

- Hosted by Dr. Masashi Ishii, Surface Physics Group, **National Institute for Materials Science (NIMS)**, Tsukuba
- Tsukuba (aka **‘Science City’**): located in Northern Kanto region, Ibaraki prefecture, approx. 45 mins (by train) NE of Tokyo
- Home to large number of HE & Scientific Research Institutes as well as a number of major Industrial HQ’s incl. e.g. Intel Japan...
- NIMS: merger of NRIM/NIRIM (est. in 50’s) is one of Japan’s largest Scientific Research Centres
- World leading research in wide range of fields in Mat. Sci.:
 - Opto-electronics, incl. growth of single crystals of diamond & boron nitride & Development of deep UV laser/LED’s
 - Superconducting & and organic materials
 - Functional (superplastic) ceramics
 - e-beam deposition techniques for growth of nanostructured materials
 - Recently demonstrated WR efficiency of emerging (Perovskite based) PV’s



Background: The Host & I...

- Met in Manchester 2012 (12 month JSPS funded visiting research position)...
- **Serendipitous conversation over coffee! uncovered common research interests;**
 - characterization of non-radiative quenching mechanisms (in order to better understand the efficiency limiting processes) in materials used for LED, Laser and Photo-voltaic (solar cell) devices
- This led to joint experiments (in UK, Japan & CLS, Canada) followed by publication of 4/5 academic journal articles (in APL, JAP, JJAP) in the next few years...
- Preparation of joint proposal (to enable continuing collab.), submitted by my host to JSPS
- For this type of fellowship, collaborative track record is a big plus!
- Awarded short term 'Invitation fellowship' late 2015



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Luminescence quenching of conductive Si nanocrystals via "Linkage emission": Hopping-like propagation of infrared-excited Auger electrons

 CrossMark

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ABSTRACT

Phosphorus (P) is an n-type dopant for conductive silicon nanocrystals (Si-nc's), the electrical activation of which may be monitored through a non-radiative Auger recombination process that quenches the Si-nc luminescence. We investigated this quenching mechanism through electrical measurements of Si-nc's. Infrared-excited Auger electron emission as the non-radiative process was directly probed and the dynamics of the process are determined from a frequency response analysis. To explain the dynamics, we propose a model in which Auger electrons with a low kinetic energy establish a local inter-nanocrystal conductance and the repetition of this local conductance results in a constant photocurrent ("linkage emission"). This emission becomes significant by electron filling in the Si-nc's owing to the electrical activation of P, which is consistent with observed luminescence quenching behavior. We found that the IR photo-excited emission is distinct from the thermally induced hopping conduction and show that confined, rather than trapped, charges are the source of the Auger electrons. Thus, the process consumes both confined charges and the recombination energy for Auger emission, which explains the luminescence quenching mechanism of Si-nc: P.

Key Topics

- Charge carriers
- Auger electron emission
- Luminescence
- Silicon doping
- Nanocrystals

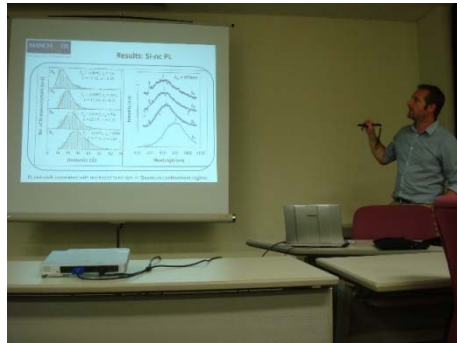
My visit...

- In addition to conducting planned experiments with my host...
- Guest seminar on my recent research activities as part of the **'Advanced Materials Characterization Project (AMCP)'** at NIMS - attended by other academic and industrial researchers from NIMS & vicinity
- Lab tours & discussion(s) with other groups, some that I knew, others I didn't...!
- This is important...! Use your time in Japan wisely to strengthen your existing network of collaborators but it's a great opportunity to look for new ones too – your host can play a crucial role here!
- Carry plenty of business cards; exchanging these at initial meetings is standard practice



My visit...

- Tour of the Southern region taking in the spectacular sites of the historic cities of **Kyoto, Nara, Osaka and Kobe** – **highly recommend (even if only as part of your tourism!)**
- Plenary talk at workshop on **‘Solution to quenching problems of nano opto-electronic materials in international framework’** - organized by my host and colleagues from Kyoto University (attended by around 60 participants from all over Japan!)



- More meetings & lab visits...get around as much as you can, especially if you have time!



Getting there...& living

- Travel: organised through Hankyu Travel International Co.
 - <http://traveltojapan.hankyu-travel.com/en/>
 - RTN flight (MAN – TKY) with JAL
 - No visa required for me as short visit – IMPORTANT for Long term visit
- Accommodation in Japan:
 - I stayed at Ninomiya House - JST managed apartment block for visiting researchers; likely similar where you will be staying
 - My appt. was located 5 mins walk from NIMS
 - Single occ. & family rooms, excellent local amenities...& events!
 - Bicycle hire (~50p/day!)
 - large community of ex-pat & visiting researchers, year-round
 - Excellent, family-friendly social environment
 - Wired internet connection in my room (WiFi not ubiquitous!)*
 - Rent & Bills paid at end of stay (from stipend)



Language

- Easier at host institute, majority of people speak very good English
 - ...although tricky at times, especially outside in social context...bars & restaurants* usually ok (images on menus usually help) but don't expect anyone at the supermarket to speak English...
 - ...BUT it's an adventure so embrace it, enjoy it and try a little Japanese, even if it's just "hello/please/thankyou..." – **it WILL be appreciated!**
 - Get yourself a phrase book to help, especially if you're going to be there longer term



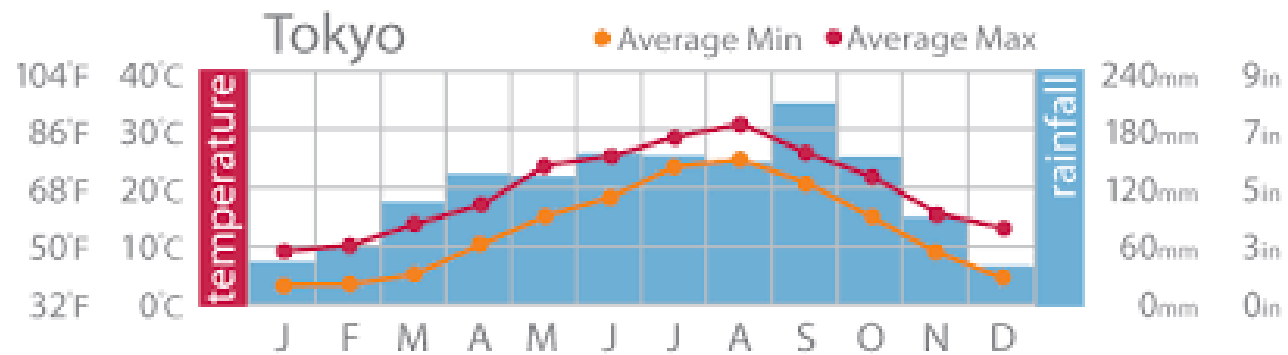
*...Japanese food is to die for!

Travel within Japan

- Easier than you think (for the most part, signs at stations etc also in English, but not always!)...
 - Local buses, trains etc are extremely efficient but (local) maps often difficult to interpret
 - Local travel cost reasonable... e.g. Tsukuba express to Tokyo, 45 mins approx. £8 each way
 - National (inter-city) travel more expensive, although in some cases covered retrospectively by JSPS (via host inst. - depends on your fellowship)
 - Shinkansen (bullet train), extremely fast & efficient e.g. (Tokyo to Kyoto in under 3 hrs, average speed 250mph!) – BUT not cheap! (approx. £120 each way) – **look into JR Rail pass BEFORE you leave** (only for sale at greatly reduced rates outside Japan)
 - Final note on travel: Trains, buses etc ALWAYS leave on time – enjoy that!

Weather in Japan

Truly a country of 4 seasons! Enjoy that too...but be well prepared, it can get extreme!



Culture in Japan

- **Generally:**
 - Yes, if you haven't been there before, prepare to be 'shocked' (in a nice way!)
 - Many things are different from what you're used to at home...
 - ...BUT don't worry about it...providing you observe the usual polite norms as you would at home then you're not going to upset anyone...go with the flow!
 - ...and **immerse yourself in the culture** fully; I can't recommend it too highly
- **At work:**
 - You'll find a very strong work ethic (which I assume you're used to..?)
 - ...if not, don't be surprised that people are working very long hours
 - Hierarchical structure at work is perhaps more obvious in Japan...
 - ...again, don't worry about it, but respect the local norms

Finally...the marketing bit!

- ...although they've asked me to tell you this...!
- I genuinely recommend joining the **JSPS Alumni Association** !
 - http://www.jsps.org/alumni_association/
- Why?
- Now that you've been awarded a fellowship, remaining part of that network will really help you to maintain the links you've opened up...can provide routes to new links
- In addition, JSPS alumni assoc. membership can provide access to additional funding schemes; i.e.
 - **BRIDGE Fellowship:** “provided exclusively for regular members of officially established JSPS alumni associations who have already conducted research activities in Japan under one of the other schemes” (<https://www.jsps.go.jp/english/e-plaza/bridge/>)
 - **Symposia/Seminar Scheme:** Provides funding for hosting symposia/seminars between collaborators in UK & Japan (http://www.jsps.org/funding/symposium_scheme/)

Most importantly – Enjoy your visit!
ありがとうございました