Nanoparticles and Space Charge

I. Contact Information

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Thomas Prevenslik is a retired Mechanical Engineer. He is an American citizen living in Hong Kong and Berlin. He no longer works for an organization and is not affiliated with any specific industry or university, although at times he works as an independent consultant.

In the US, he worked for Owens-Illinois on optical telescopes and gas bearings associated with the Moon program before joining Westinghouse in research on advanced nuclear reactors. Thereafter, he worked for US companies on an hourly contract basis in the ANSYS analysis of aircraft jet engines and nuclear projects. In Tokyo, he worked at Cybernet Systems in the leasing of ANSYS and ABAQUS software by solving problems for Japanese companies, e.g., at Fujikura Ltd. in the ANSYS analysis of polyethylene (PE) in high voltage power cables. Of relevance to this proposal, over the past 5 years he developed the physics of QED induced EM radiation. Here QED stands for quantum electrodynamics and EM for electromagnetic.

II. Technical Approach

A. Nanoparticles and Space Charge

It is widely known that PE additives increase space charge. But space charge is also observed in additive-free PE. Injected electrons from electrodes aside, impurities are the likely source of space charge. In this proposal, the impurities of interest are submicron nanoparticles (NPs) comprising clusters of inorganic atoms or organic molecules having dimensions < 50 nm. Space charge is produced from NPs that form in PE by QED induced RM radiation.

To understand how NP impurities produce space charge, one must turn to quantum mechanics (QM). Atoms in NPs under EM confinement at vacuum ultraviolet (VUV) frequencies are required by QM to have vanishing kT energy and specific heat. Hence, isolated NPs do not acquire kT energy by heat flow from the thermal surroundings. Indeed, NPs may only acquire full kT energy by attaching to and becoming a physical extension of the continuum of surrounding PE molecules that by QM is not restricted to vanishing kT energy. NPs as a part of the PE continuum acquire full kT energy and emit EM radiation in the far infrared (FIR).

Under electrical stress, the atoms in NPs that detach from the PE continuum have full kT energy in excess of the vanishing kT energy allowed by QM. Since the NPs also have vanishing specific heat, the excess kT energy cannot be conserved by an increase in temperature. Instead, conservation proceeds as the FIR radiation in the NPs is induced by QED to undergo frequency up-conversion to the VUV confinement frequency of the NP. The Planck energy produced at VUV levels removes electrons from NP atoms leaving the NPs with a positive space charge that induces negative charge in the otherwise neutral PE continuum. By electrostatic attraction, the NPs reattach to the PE continuum to once again acquire full kT energy, thereby allowing the NPs to accumulate multiple space charges in subsequent NP detachments. Absent electrical stress, NP space charge may be similarly produced under low level mechanical or thermal loading.

Typical applications of QED induced EM radiation include not only space charge by NPs in power cables, but numerous other applications including:

Static Electricity – Person walking acquires charge as their shoes detach NPs from carpet fibers.
Atmospheric Electricity – Charging by ice NPs produced in rubbing of frosted graupel and ice.
Spray electrification – Charge produced as liquids upon expansion produce NPs.
Nanocatalysts – NPs produce Planck energy at VUV levels to enhance chemical reactions.
Nanofluids – NPs gain heat from fluid that is loss as penetrating VUV escapes the fluid.
Tribochemistry – Chemical reactions enhanced by VUV as NPs form upon rubbing.
Flow electrification – NP impurities charge oils similar to space charge in PE insulation.
Cancer therapy – NPs under IR radiation emit VUV that kills cancer cells.

B. Proposed Approach

The proposed objective for space charge suppression in PE insulation is to limit:

(1) Submicron NP impurities in PE, or
(2) VUV radiation produced from NPs.

To accomplish this objective, the possible approaches are:

(1) Removal of submicron NPs, and
(2) Adding VUV blockers to PE.

Initially, extensive interaction among the Respondent and personnel in the Client's laboratory is required to determine the most feasible approach in achieving the proposed objectives. Specimens would then be made and tested, say by ESR spectrometry or acoustical PEA under electrical stress. If necessary, final modifications are made and a new set of specimens tested. Results are summarized in a final report.

C. Challenges to be Overcome

There is no question that QED induced EM radiation at VUV levels from submicron NPs is the source of space charge in PE insulation under electrical stress. However, limiting the NP impurities in PE may be very difficult. For example, in flow electrification it is almost impossible to eliminate charge by filtering submicron NP impurities from coolant oil. Moreover, NPs of TiO_2 as VUV blocker additives in PE may actually increase space charge because the NPs like impurities act as VUV sources. In yet unknown challenges, the close interaction of the Respondent with the Client's personnel cannot be overemphasized.

III. Proposed Budget

A. Expected Development Budget

Respondent proposes to initiate the development of PE power cable with limited space charge on a contract basis over a 3 month period at an hourly rate of US $50 / hour plus travel and per diem. Contract extensions may be made at this time.

B. Proposed (Supply and Licensing) Condition

QED induced EM radiation is under copyright. Any "derivative works" that depend upon or develop from copyright may only be made with the expressed written consent of Respondent.

C. Position on Intellectual Property

Intellectual property (IP) derived from mutual effort of the Client and the Respondent over the course of the contract usually follows from the "work for hire" where the Client retains exclusive copyright is herein limited as follows: Should QED induced EM radiation be fundamentally altered in the manner of "transformative derivative work," copyright shall be the joint IP of the Client and Respondent.

IV. Experience (Patents and Papers)

US patent 20030178616 - "Cavity QED Processes", 2003. See www.nanoqed.net under www.geocities.com/thomas_prevenslik in links "2004" and "Patent." Emphasis is placed on nanocavities to provide the EM confinement for NPs. In this proposal, the EM confinement is explicitly extended to NPs that provide their own EM confinement.

"Space charge in submicron cavities by quantum electrodynamics?," IEEE Conference on Electrical Insulation and Dielectric Phenomena, Nashville, 2005. See www.nanoqed.net under www.geocities.com/thomas_prevenslik in links "2005" and "Space Charge in Power Cables." The claim is made that space charge is produced by the VUV produced by QED in the formation of submicron cavities under low stress levels.

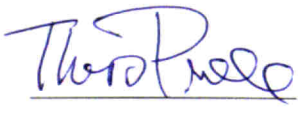
"Space charge and aging," presented at ISH 2007, Ljujbljana, 2007. See www.nanoqed.net under www.geocities.com/thomas_prevenslik in links "2007" and "Space Charge." Space charge is produced by the VUV in the QED cavities that form as PE molecules scission under low stress levels suggesting that VUV blockers added to the XLPE during fabrication might reduce space charge.

"Flow electrification by nanoparticle impurities," ICDL 2008, Poitiers, 2008. See www.nanoqed.net at the link "Flow Electrification by Nanoparticles." The similarity of oxidation of coolant oil to aging in PE cables suggests space charge may be reduced by adding liquid UV blockers, such as Tinuvin®, that blend homogeneously with the XLPE in cable fabrication.

"Flow electrification by nanoparticle impurities," SFE 2008, Paris Gif/Yvette, 2008. See www.nanoqed.net at the link "Natural Processes." The conversion of transient thermal kT energy in the formation of NPs in rubbing by solids in static electricity, and frosted graupel and solid ice in thundercloud electrification is by analogy the same as the space charge produced in the detachment of NPs from PE molecules under electrical stress.

Respondent,

Thomas Prevenslik



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