

個人情報

最近の研究課題：「紫外光による空気からの新規な水エアロゾル、水滴生成」

集中講義

北海道大学工学部、東北大学理学部、筑波大学大学院、東京大学工学部・薬学部、東京都立大学工学部、群馬大学工学部、名古屋大学理学部・工学部、京都大学理学部・工学部、大阪大学理学部、広島大学理学部、九州大学など。

賞罰

昭和 38 年 5 月	フルブライト奨学金
昭和 58 年 5 月	レーザー学会進歩賞
平成 6 年 3 月	Daiwa-Adrian Award
平成 8 年 5 月	レーザー学会功労賞
平成 8 年 3 月	日本化学会賞
平成 13 年 1 月	Cochiver Lectureship Award
平成 14 年 1 月	Mizushima-Raman Lectureship Award
平成 17 年 6 月	インド化学会名誉会員
平成 19 年 10 月	光化学協会功労賞
平成 20 年 11 月	アジア光化学協会功労賞

委員会・審議会など

昭和 59 年 4 月	科学技術会議専門委員
昭和 61 年 2 月	学術審議会専門委員会（科学研究費分科会）
平成 2 年 4 月	日本学術振興会特別研究員等審査会委員
平成 5 年 4 月	総合研究大学院大学評議員
平成 5 年 4 月	日米科学協力事業委員会委員
平成 5 年 4 月	日本学術会議日韓基礎科学合同委員会専門委員会委員
平成 6 年 1 月	学術審議会専門委員会（科学研究費分科会）
平成 6 年 9 月	東京大学物性研究所協議会委員 8.8 まで
平成 6 年 10 月	日本学術会議化学研究連絡委員会委員
平成 7 年 2 月	学術審議会専門委員会（科学研究費分科会）8.1 まで
平成 8 年 4 月	日本学術振興会日印協力事業コーディネーター
平成 8 年 4 月	学術審議会専門委員会（科学研究費分科会）
平成 9 年 6 月	高エネルギー加速器研究機構運営協議員 4 年
平成 9 年 6 月	高エネルギー加速器研究機構物質構造科学研究所運営協議員

平成 9 年 7 月	日本学術会議会員（18期、18期、19期（第4部所属、学術体制常置委員会、科学研究費部会所属））
平成 9 年 10 月	同化学委員会物理化学小委員会委員長
平成 11 年 4 月	東北大学理学部外部評価委員
平成 11 年 4 月	日本学術振興会日印自然科学協力事業合同評議会委員
平成 15 年 1 月	同共同議長（日本側委員長）
平成 13 年 4 月	文部省「国立大学等独立法人化に関する調査検討会議」組織業務委員会委員
平成 13 年	文部科学省科研費「特定領域研究」「光機能界面」総括班員
平成 14 年 2 月	日本学術振興会日韓基礎科学合同委員会委員
平成 15 年 5 月	同共同議長（日本側委員長）
平成 14 年 4 月	奈良先端科学技術大学院大学創生科学研究科アドバイザー
平成 15 年 5 月	日本学術振興会未来開拓事業推進委員会委員
平成 15 年	文部科学省科研費「特定領域研究」「水と生体分子」推進委員
平成 15 年	科学技術振興機構 戰略的創造研究 C R E S T 「医療に向けた自己組織化等の分子配列制御による機能性材料・システムの創製」アドバイザー
平成 16 年	文部科学省科研費「特定領域研究」「極微構造反応」推進委員
平成 19 年	文部科学省科研費「特定領域研究」「分子高次系」評価委員
平成 20 年	科学技術振興機構 戰略的創造研究さきがけ「光の利用と物質材料・生命機能」領域アドバイザー
平成 20 年 5 月	名古屋大学大学院理学研究科物質理学外部評価委員

学会等

昭和 55 年 1 月	米光生物学会正会員（編集幹事）
昭和 55 年 7 月	光化学協会常任役員
昭和 58 年 5 月	レーザー学会評議員
昭和 58 年 5 月	日本化学会東海支部幹事
平成 3 年 6 月	レーザー学会理事 7。6まで
平成 11 年 6 月	レーザー学会評議員 光化学協会常任理事・理事

学会誌編集委員、編集幹事、編集委員長
日本化学会欧文誌、
光化学（編集委員、編集長）
レーザー研究、
Chemical Physics,
Chemical Physics Letters,
Journal of Physical Chemistry (米化学会)
Photochemistry and Photobiology (米光生物学会誌、編集幹事)
Journal of Luminescence,
Laser Chemistry,
ChemPhysPhysChem,など。

国際学会運営

昭和 49 年 9 月 1975 ルミネッセンス国際会議組織委員会専門委員
昭和 63 年 8 月 超高速現象国際会議国際組織委員
平成 10 年 10 月 環日本海科学技術会議組織委員長
平成 14 年 8 月 第 21 回国際光化学会議組織委員
日米太陽エネルギーの化学変換会議、Okazaki Conferences の主催（数回）など多数。

産業界協力

昭和 62 年 11 月 (財) レーザー技術総合研究所評議会委員
(財) 光科学技術研究振興財団審査委員
平成 11 年 6 月 (財) 石川県産業創出支援機構評議員
昭和 62 年から 出光興産と有機金属化合物の光連鎖反応による高効率金属薄膜、
金属酸化物の形成法を発明（国際特許）
平成元年から 富士写真フィルムと写真の色増感初期過程を解明。

論文

原著論文	; 287 報
プロシーディングス	; 46 報
総説、著書	; 71 報
その他	; 10 報

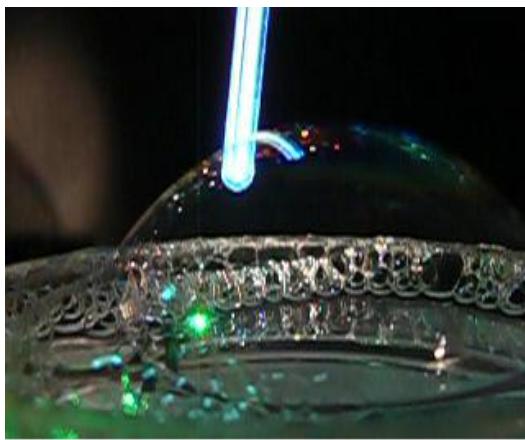
これまでの主なる研究成果

1、「紫外光による空気からの水滴生成の研究」

紫外光を湿潤空気に照射すると水滴や氷粒が生成するという新現象を 2005 年に見出した。¹⁾ 光照射によって気相分子から液滴や固体が生成する現象は古くから知られていて、1869 年チンドルが気相有機物と塩酸の混合気体を光照射して散乱気体を作ったのが最初とされている。²⁾ その後、真空紫外光による水蒸気からの水滴生成、ベンゼン蒸気の光励起による高分子の生成、気相の有機金属化合物の光誘起連鎖反応による金属の分離などが報告されている。しかし、これまでの研究報告は散発的で、記述的な段階に止まっている場合が多くあった。³⁾

本研究で用いた系は光と空気という単純な組み合わせであり、また水は重要な物質であるので本現象は特に興味深い。

光源の波長は 200nm 近傍であれば定常光源の低圧水銀燈であってもパルス光源のエキシマーレーザーであっても本現象を誘起できる。原料は通常の空気で湿度温度範囲はほぼ任意であるが、湿度によって水滴生成速度、粒子の大きさが決定されるので、反応場は非常に重要である。過飽和状態を作ると大きな粒子は出来やすくなる。例として、せっけん薄膜(シャボン玉の北半球)の実験を図1に示した。せっけん液と周囲の温度に差がつけてあり、シャボン玉の中は過飽和になっている。ペン型の低圧水銀燈を数秒照射するだけで 10 秒程度の短時間で粒径数十ミクロンの水滴が生じ、成長する。

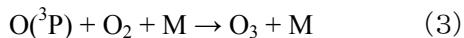


1、左図：シャボン玉(北半球)にペン型低圧水銀燈を数秒点灯する。右図：数秒の照射後に生成した水滴。シート状にしたレーザー光による光散乱で観測したもの。

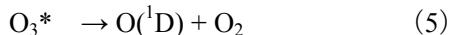
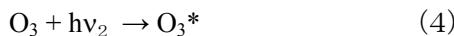
この反応は後述のような純粹な光化学反応であるから粒子の大小を選ばないのなら殆んどどのような温湿度条件でも見られる。例として 50°C の高温で、相対湿度 10% という乾燥状態でも粒子は多数生成(1 cc 当たり、数 100 万個)する。ただし、このよう名条件では粒子は成長しない(例、粒径が約 50 nm で止まる)。

反応機構を研究した結果、結論とし空気中の酸素の光分解とそれに伴う反応で最終的に過酸化水素が生成しこれが核になるものと考えている。詳しく述べると次の反応機構が想定される(主要反応ルートのみ記述)。⁴⁾

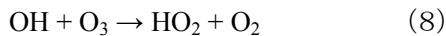
酸素の光解離とオゾン生成。



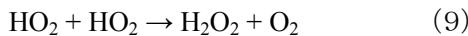
オゾンの光解離と酸素原子 O(¹D)の生成。



OH ラジカルと HO₂ ラジカルの生成。



最終安定物質過酸化水素(H₂O₂)の生成。



全体の反応の基点となるのは酸素の解離反応であるので、200nm 近傍の光が必要となる。安定生成物の過酸化水素の蒸気圧は水の蒸気圧より 2 枠小さいので水が凝集すると考えられる。反応中間体も水の凝集に一定の役割を持つかもしれない。反応中間体の検出と関連する 30 の素反応(6 つの光化学反応、ラジカル中間体と水との錯体形成を含む)のシミュレーションには良好な一致が見られる。⁴⁾ 本反応の気相反応部分はシミュレーションによって正確に求めることが出来る。しかし、気相から粒子が生成し、成長する機構は複雑であり、更なる研究を要する。

光によって空気から水滴作ることには技術の進歩によってはかなり興味ある応用が生まれる可能性がある。水滴粒子が十分に成長する気象条件があれば人工降雨の可能性が生まれる。古典的な物質散布の方法に比べて、光照射にはいくつかの優れた特徴があると考えられる。水滴が大きく成長しない場合でも多数の水滴を大気に作ることが出来れば、太陽光の地球による反射(アルベド)を制御して温暖化防止に役立つかもしれない。

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他の研究業績

2、「超短パルスレーザーとコヒーレント非線形分光法の開発」

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3、「気相化学反応による粒子の生成」

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6、「カラー写真の増感初期過程の研究」

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11. "Charge-Transfer Interaction and Fluorescence in Some Tetracyanobenzene Complexes"
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