Design of a New Generation Molecular Beam Machine

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We present the design of a new molecular beam machine capable of elucidating the formation of carbonaceous molecules relevant to combustion chemistry and astrochemistry. The machine includes the following critical components:

1. **Main Chamber (MC)** is a 304 stainless steel box (120 cm × 120 cm × 70 cm; 778 L) and pumped by 2400 L/s magnetically suspended turbo molecular pumps (Osaka TG2400M) [1].
2. **Reflection Time-of-flight mass-spectrometer** (**RETOF**) produced by Jordan TOF Products, Inc. RETOF is connected to one turbo molecular pump (Osaka TG420M; 400 L/s). One scroll pump (Edwards XDS35iC; 10 L/s) backs the turbo pumps of the MC and RETOF.
3. **Source Chamber (SC)** is located inside the MC so that the reactant beam goes between a repeller plate and an extraction grid of the RETOF. SC is evacuated by a maglev pump (Osaka TG2400M) backed by a dry roots pump (Leybold WS505; 140 L/s) roughed by one scroll pump (Edwards XDS35iC).
4. **Pulse Valve.** The piezo-electric valve is designed for generation of short gas impulses (80 μs) at high repetition rates and high gas flow. Mounted in the SC in front of a skimmer (1 mm) on the XYZ translation stage.
5. **Pyrolytic source.** Consists of a resistively heated SiC tube of 22 mm length, 1 mm inner diameter; the achievable highest temperature of the tube was estimated to be around 1300–1400 K. The electrical heating and mounting of this tube occurs through two silicon carbide electrode sleeves and two molybdenum electrode blocks [2].
6. The frequency **tripling gas cell** (length 269 mm, diameter 35 mm), into which 355 nm pulsed, seeded Nd/YAG tripled laser radiation is focused, is used to generate the 118 nm (10.5 eV) radiation. The tripling cell contains a mixture of Xe and Ar gas (~1/10, 200 Torr) [3].

The new machine will allow us to measure product distributions for various unimolecular (pyrolytic) and bimolecular reactions under combustion-like conditions.

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