

Where Colloid Science meets Space Science: Synthetic Mimics for Nitrogen-based Polycyclic Aromatic Hydrocarbon Cosmic Dust

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We report the preparation of the first synthetic mimic for submicron-sized nitrogen-based polycyclic aromatic hydrocarbon (PANH) cosmic dust. Melting point phase diagrams were constructed for two binary mixtures comprising *N*-phenylcarbazole (m.p. 96 °C) with either *N*-ethylcarbazole (m.p. 71 °C) or *N*-propylcarbazole (m.p. 50 °C) to identify their eutectic compositions and temperatures, respectively. Each eutectic composition was then processed above its eutectic temperature via hot emulsification using a commercial water-soluble polymeric emulsifier: high-shear homogenization produced polydisperse molten PANH droplets of approximately 60-70 μm diameter. Each precursor emulsion was then subjected to high-pressure microfluidization to produce much finer submicron-sized PANH droplets. On cooling to 20 °C, these hybrid PANH microparticles were coated with an ultrathin overlayer of polypyrrole (PPy). This electrically conductive coating enabled the efficient accumulation of surface charge, which in turn allowed the electrostatic acceleration of such PPy-coated PANH microparticles up to the hypervelocity regime using a high-voltage dust accelerator. Firing a *single* 71:29 *N*-propylcarbazole/ *N*-phenylcarbazole microparticle into a gold target at 3.6 km s⁻¹ led to impact ionization and the *in situ* generation of an ionic plasma. Subsequent time-of-flight mass spectrometry analysis confirmed the formation of the characteristic parent cations for *N*-propylcarbazole and *N*-phenylcarbazole, respectively. Such laboratory-based experiments augur well for the unambiguous identification of PANH-based cosmic dust by next-generation impact ionization mass spectrometers to be deployed in current and future space missions.

Keywords:

polycyclic aromatic hydrocarbons, emulsions, cosmic dust, eutectic composition, polypyrrole, impact ionisation mass spectrometry, synthetic mimic