Production of Electrophilic Radiohalogen PET Synthons: $[^{18}F]F_2$ and $[^{34m}Cl]ClF$

Jonathan Engle

Synthesis of high specific activity electrophilic radiohalogens has eluded all but a few radiochemists for more than three decades. As a result, most radiochemistry for PET imaging has relied on nucleophilic substitution $[^{18}F] \leftrightarrow X$, presupposing a designer precursor with a suitable leaving group X. However, exchange reactions between two aryl radiohalogens, ^{18}F and ^{34m}Cl, and umol quantities of F_2 gas in electrical discharge plasma now produce $[^{18}F]F_2$ and $[^{34m}Cl]ClF$ for electrophilic syntheses at Wisconsin. These electrophilic synthons facilitate initial experiments with the incorporation of radiohalogens into organic molecules by simplifying the stereochemistry of the required precursor and reducing the burden of unwanted chemical impurities through increased specific activity.

The latter radiohalogen, ^{34m}Cl, is produced uniquely at Wisconsin via the (d,α) nuclear reaction on enriched ^{36}Ar gas. This reaction affords the first "clean" production of this orphan β^+ emitter in yield and form suitable for subsequent radiochemistry; moreover, the availability and cost of ^{40}Ar gas as a lab consumable makes the inexpensive chemical surrogate ^{38}Cl readily available for developmental cyclotron targetry and radiochemistry.

$[^{18}F]F_2$, long a preferred synthon in our lab, is now produced reliably post-target in high voltage discharge plasma with a factor of 10 reduction in added carrier fluorine. In addition to increasing the cleanliness of electrophilic fluorination reactions, our method broadens the scope of our achievements with automated radiochemical synthesis systems in collaboration with the Danish company Scansys.