FOSTER
DELIVERY SCIENCE




Contract Research & Manufacturing

Pharmaceuticals & Combination Products

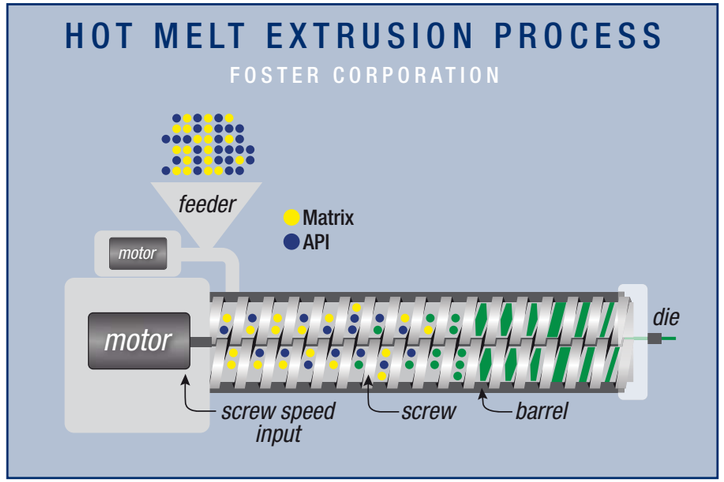
HOT MELT EXTRUSION

Hot melt extrusion is the process of melt blending active pharmaceutical ingredients (APIs) and polymers in an extruder, which de-aggregates the API into small particles. Within the extrusion process, mechanical energy influences the degree of mixing achieved and thermal energy determines the amount of heat the formulation experiences in the process.

A number of variables are used in the extrusion process to optimize a given formulation, including but not limited to barrel and screw designs. Extruder barrels are zoned in sections which are individually heated and cooled depending on the formulation process parameters. Extruder screws are individually constructed with components that assist in melting (via shear forces) and convey material through the barrel, while mixing and homogenizing the formulation.

This technology is suitable for both high dose and potent compounds and has been proven to provide sustained, modified, and targeted drug delivery. Melt extrusion can be used as a process for the manufacture of most dosage forms. Foster's inventory of downstream processing equipment is available to manufacture traditional and customized shapes including:

- Powders, granules and pellets for encapsulation
- Tablets
- Films (buccal, transdermal)
- Rods, fibers and 3D printing strands
- Implants
- Customized dosage forms



BENEFITS

MELT EXTRUSION ALSO OFFERS SEVERAL COST AND PERFORMANCE ADVANTAGES OVER TRADITIONAL PROCESSING TECHNIQUES

- Improved solubility
- Improved dissolution
- Improved stability
- Volume and scale up flexibility
- Taste enhancement
- Improved bioavailability
- Improved dispersion
- Controlled release rates
- Accommodation of various size molecules
- Dose form and aesthetic flexibility

APPLICATIONS

Poorly Soluble Drugs

Active pharmaceutical ingredients (APIs) that cannot be processed using traditional, aqueous methods.

Solid Dispersions

Alternative to solvent processes for solid molecular dispersions, including high dose forms and potent compounds.

Resorbable Implant Delivery

Drug/device combination products with tailored rates of bioabsorption for controlled or local release of API's.

Non-Resorbable Implant Delivery

Local or systemic drug delivery of API's using non-absorbing polymers that can be removed at the conclusion of therapy.

CONTRACT RESEARCH AND MANUFACTURING

Foster Delivery Science's pharmaceutical melt extrusion is performed in a cGMP clean room production facility using single and twin screw extruders qualified and designed for drug delivery applications. Our equipment and extruders allow us to work with as little as 25 – 50 grams of material for proof of concept and early formulation development. We can scale to a 27mm twin screw extruder for clinical trials and commercial manufacture.

CONTRACT RESEARCH & DEVELOPMENT

Process Development

To facilitate in process formulation development, our engineers characterize each formulation for thermodynamic and rheological properties. This data is for initial computer simulation of screw and barrel designs, and initial process conditions. Processes are evaluated, optimized and scaled on one of several extruders in our development lab or clean room facility.

Clinical Supplies

Foster Delivery Science has the equipment, facilities and personnel to support cGMP clinical studies. Our clean rooms and equipment are qualified and documented to industry quality standards. The Foster Delivery Science team has manufactured clinical trial materials for preclinical studies, Phase I, Phase II and Phase III, including an 800kg batch for a Phase III study.

Process Scale-up

We offer a range of extruders to support scale-up of formulations from laboratory to clinical and production equipment at our facility or on a contract basis for processing at an alternative location. To ensure scaled formulations have identical physical and chemical properties we match mechanical and thermal process energies between the extruders using computer aided process simulation software. This provides an initial screw design and process conditions for the larger equipment. Scaled-up extrusion trials are then performed and samples are characterized. Iterative trials may be employed if further refinement is required.

CONTRACT MANUFACTURING

Foster Delivery Science provides manufacturing services in accordance with FDA Current Good Manufacturing Practices. Our quality management systems, raw material handling procedures, operating procedures, deviation detection and investigation protocols and laboratory testing maintenance assure proper design, monitoring and control of manufacturing processes and facilities.

FORMULATION

Foster Delivery Science offers rapid screening studies to provide proof of concept and feasibility information, used to identify stable lead formulations and drive pre-clinical and Phase I decisions.

- *Pre-Formulation Studies*- Excipient compatibility studies
- *Solubility Screening*- Solid Dispersions; Surfactant and co-solvent screenings; Analytical characterization of solid dispersions (kinetic solubility, dissolution rate)
- Proof of Concept Studies- Identification of lead binary polymer / drug formulations; Characterization and generation of stability information

PROJECT EXECUTION

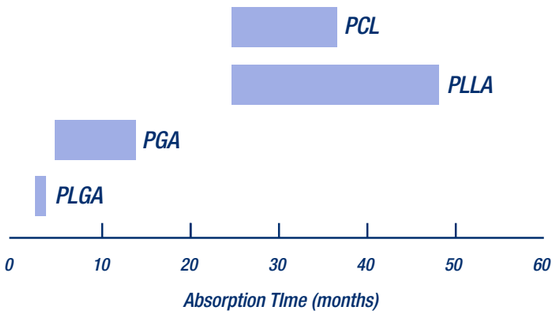
Foster Delivery Science provides project management expertise for the successful execution of drug development programs. All programs are executed through a project-centric team, with a lead project manager. Our project managers are certified Project Management Professionals.

COMMON POLYMERS FOR HOT MELT EXTRUSION

Type	Polymer	Abbreviation	Softening Temperature (°C) Tg	Tm
Soluble	Hydroxypropylmethyl cellulose	HPMC	175	
	Hypromellose acetate succinate	HPMCAS	120-130	
	Poly (vinyl pyrrolidone)	PVP	136-168	
	Poly(ethylene oxide)	PEO		25-80
	Poly(vinyl pyrrolidone) vinyl acetate copolymer	COPOVIDONE	106	
Resorbable	Poly (lactic acid)	PLA		55-65
	Poly (lactide-co-glycolide)	PLGA		40-60
	Polycaprolactone	PCL		60
Durable	Poly(ethylene vinylacetate)	EVA		35-205
	Thermoplastic Urethane	TPU		200-450

BIORESORBABLE POLYMER IMPLANT DURATION

(DEPENDENT ON POLYMER MOLECULAR WEIGHT)



QUALITY SYSTEMS

At Foster, pharmaceutical development and manufacturing begins with a complete commitment to quality. Our quality and regulatory systems represent excellence throughout every aspect of our business. In turn, our customers can count on reliable products and service throughout the entire life of the project.

Certifications and Registrations

ISO 9001: 2008
ISO 13485 : 2003
FDA Registration
DEA Registration for Class II-V substances
Validation – Process & Test Methods
Production – Implement Manufacturing Protocols

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