INNOVATION | SUSTAINABILITY | QUALITY

Controlled Release Technologies (CRT) – New Inorganic Solutions, Alternatives to Polymers

Ceram is a materials technology consultancy that focuses on innovation, sustainability and quality assurance of materials.

Partnership is central to how we do business; we work with our clients to understand their needs so that we can help them overcome materials challenges and develop new products, processes and technologies to improve profitability.

Why Controlled Release?

The gradual liberation of active ingredients over a period of time, commonly known as controlled release, presents multiple advantages for different types of industries. By keeping the dosage at a certain level for a continued period of time, a more efficient action of the delivered agent is achieved and side effects, such as a too high (toxic) or too low (ineffective) dose, are reduced. Other benefits for manufacturers include a reduction in the level of active ingredients required to achieve the same effect, due to a more efficient availability, and the offer of new delivery routes which protect incompatible or unstable compounds, only liberating them when their action is required.

At Ceram, we have combined our appreciation of these controlled release challenges with our extensive knowledge of materials and viable processing technologies to develop a range of tailored solutions.

Why Use Inorganic Materials in Controlled Release Technologies?

Glass and ceramic materials have unique properties that make them excellent candidates as carriers for sustained release. They:

- Present controllable thermal and chemical resistance
- Do not react with solvents – something which most polymers are susceptible to
- Do not swell or change structure under pH or temperature variations – this reduces potential high dose-dumping problems which are commonly encountered in polymeric systems.

What's Unique About Our Controlled Release Technologies at Ceram?

Using our considerable knowledge of inorganic materials we can design bespoke release characteristics through an appreciation of how changes to material chemistry alter key properties such as rate of dissolution, level of porosity in final product, etc. The ability to control physical properties such as particle size and porosity also has a role to play.

We can modify the solubility of glasses and ceramics to suit the requirements of delivery and composition to ensure good compatibility and low toxicity.

We offer tailored solutions for each client.

Controlled Release Technologies (CRT) – New Inorganic Solutions, Alternatives to Polymers (continued)

How Do We Do This?

Through materials design, formulation and processing.

- Conventional glasses prepared via fusion
- Water glasses: coating, binding and encapsulation
- Sol-gel glasses/ceramics: low temperature processing
- Bioactive glass-ceramics.

Properties:

- Tailored to meet specific requirements: chemical durability, solubility
- Design and control of the release rate
- Micro/nano structures with controlled porosity
- Inert carriers or functional agents
- Strategic market sector focus: healthcare, biomedical, cosmetics, pharmaceutical, household, paints.

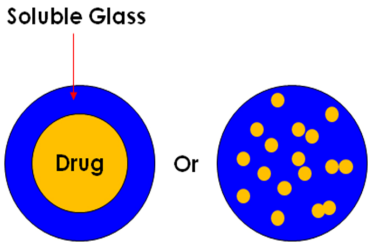
According to composition and type, these may be:

- Biocompatible
- Bioactive
- Structurally stable
- Uniformly biodegradable
- Used as carriers or active ingredients.

Introducing Drugs into Glass

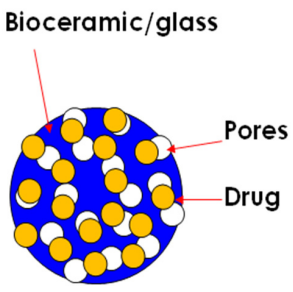
Drug embedded in solid soluble glass matrix:

- As a thin glass coating around drug (providing delayed release)
- As a homogenously dispersed drug in a glass (providing slow release)



Drug embedded within a solid, porous matrix:

- Can be synthesised/processed to produce a range of ‘micro’ and ‘macro’ structures



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Are They Safe?

Appropriate combinations of glass and ceramics are naturally biocompatible and contain basic elements already in the body, such as those in bone. In general, they should be safer than organic based synthetic polymers.

Types of Controlled Release Technologies Currently in Development at Ceram

Option 1: Conventional Glasses

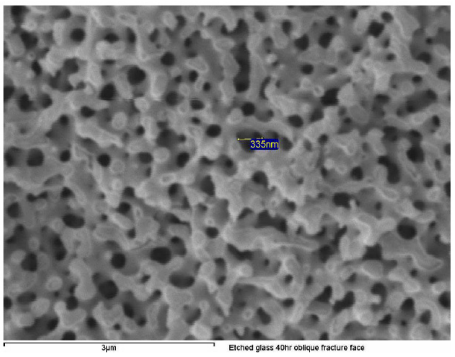
Formed via Fusion or 'Water-Glass' Routes

Fusion route:
Flexible, large scale, potentially cheap raw materials. However, the high temperature does not allow the incorporation of organic species. In these instances, primary fused glass particles need to be converted into porous structures (see option 3, section 3 below) with subsequent active ingredient impregnation loading.

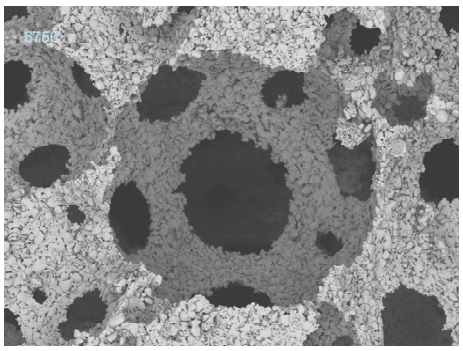
Water-glass route:
Certain glass compositions are soluble in water. Active ingredients for release can be added; such species will show sustained release via subsequent re-dissolution.

Sodium silicates are GRAS – Generally Regarded as Safe, listed as indirect food additives, and have been commonly used in tablets to aid disintegration.

Phase separated glass



Foamed particulate glass



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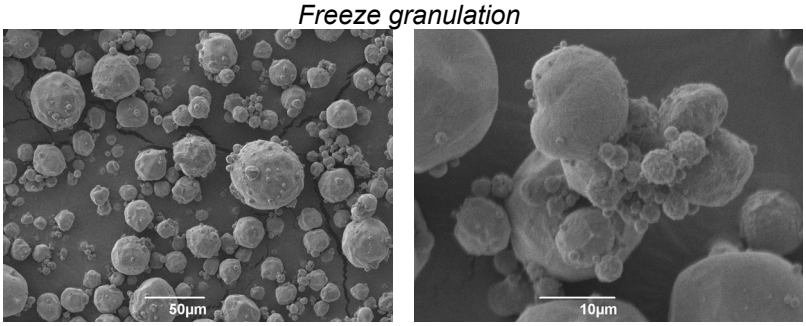
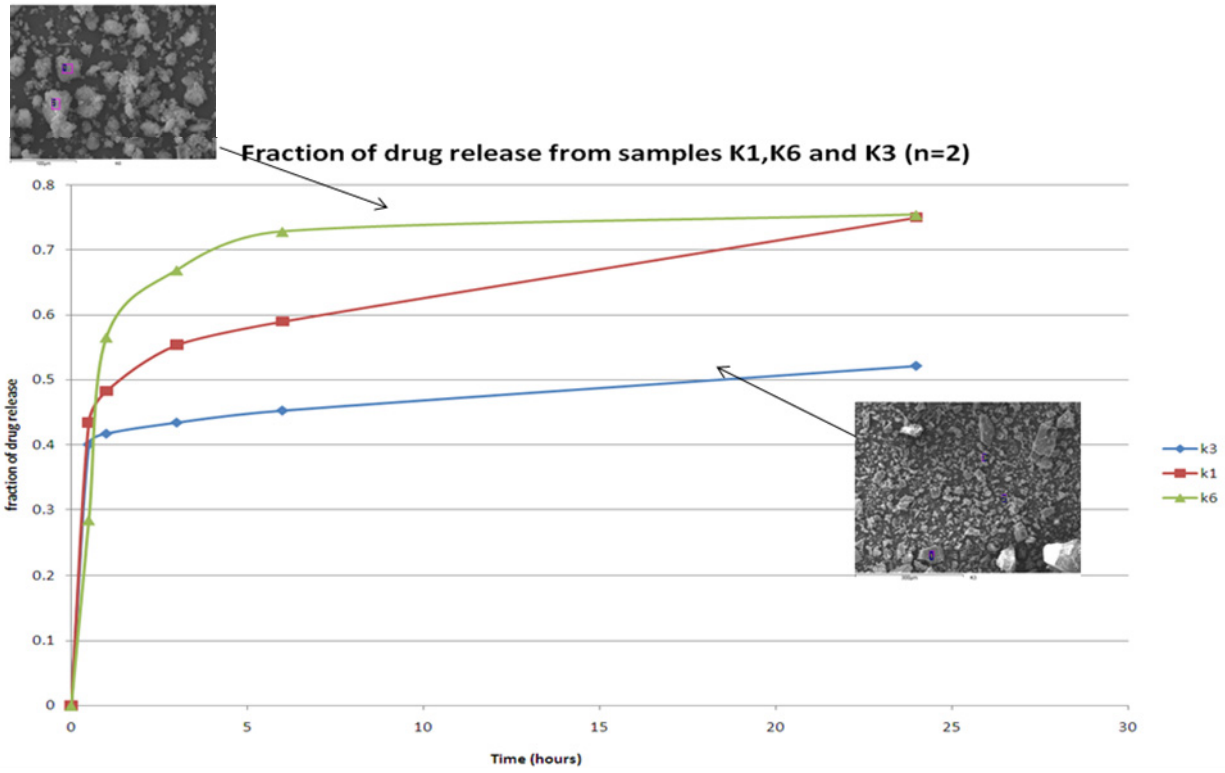
Freeze granulation



Option 2: Sol-Gel-Based Glasses

Sol-gel techniques comprise the transformation from a solution containing the glass precursors into a solid network. By adding sacrificial agents it is possible to obtain porous structures to be loaded with the agent to be released. Compared to fusion derived glasses, sol-gel glasses and ceramics present bioactive properties which are not solely determined by the composition and the choice of the precursor materials but also by the final porous and ordered structure.



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Option 3: Bio-Glasses, Bioactive Ceramics and Related Materials as Inert Carriers and/or Functional Agents

- Can be prepared by either of the previous synthesis routes
- Fine tuning of the desired solubility by adjusting the compositional parameters during synthesis
- The selection of the synthesis route and post synthesis process enables the tailoring of properties
- Intrinsic functionality: bioactivity assessment based on hydroxyapatite deposition (ISO 23317) and determination of cell proliferation and alkaline phosphate activity (ISO 10993).

Combination of the above technologies and bespoke combinations for specific, targeted applications are available.