

60 YEARS OF GLASS-CERAMICS R&D: A GLORIOUS PAST AND BRIGHT FUTURE

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Glass-ceramics - materials produced by controlled crystallization of certain glasses - were discovered 60 years ago. A wide range of properties is possible because of the ability to design their composition and thermal treatment:

- Composition: Many compositions can be vitrified which could be crystallized to form a glass-ceramic.
- Forming: Articles of any shape can, in principle, be made by any other glass-processing method that already exists or may be invented.
- Thermal treatment: Crystallization can be induced on the cooling or heating path, in one or multiple steps.
- Microstructure: Articles can be engineered from nanograins, micrograins or macrograins; low or high crystallinity; zero, low or high porosity; one or multiple crystal phases; random or aligned crystals; and surface-induced or internal crystallization.
- Thermal properties: Thermal expansion can be controlled – from negative to zero or highly positive; stability can range from about 400°C to 1,450°C; and low thermal conductivity is common.
- Mechanical properties: Articles have much higher strength and toughness than glasses, but the limits are far from being reached, possibility to be further strengthened by fiber addition, chemical and thermal methods. They are hard, some are machinable.
- Chemical properties: Articles can be resorbable or highly durable.
- Biological properties: Articles can be biocompatible (inert) or bioactive.
- Electrical and magnetic properties: Articles can have low or high dielectric constant and loss, high breakdown voltage, ionic conducting or insulating, superconducting, piezoelectric and ferromagnetic properties.
- Optical properties: Articles can be translucent or opaque, opalescent, fluorescent, and colored and photo-induction nucleation are possible.

Many challenges in glass-ceramic research and development are ahead. They include the search for new compositions and new or improved crystallization processes. From their glorious past, to their very successful commercial products as well as their impressive range of properties and exciting potential applications, glass-ceramics have indeed a bright future!