entrapped active agents can then be incorporated into many product forms, such as creams, lotions, powders, and soaps. After the product is applied, the entrapped materials are then delivered to the skin in a controlled time-release pattern or a preprogrammed manner through the use of several different "triggers": rubbing or pressing the microsponge after it has been applied to the skin; elevating skin surface temperature; introducing solvents for the entrapped material, such as water, alcohol, or even perspiration; and controlling the rate of evaporation.

Like a true sponge, each microsphere consists of a myriad of interconnecting voids within a noncollapsible structure with a large porous surface. The size of the Microsponge can be varied, usually from 5 to 300 μm in diameter, depending upon the degree of smoothness or after-feel required for the end formula. Although the Microsponge size may vary, a typical 25-μm sphere can have up to 250,000 pores and an internal pore structure equivalent to 10 ft in length, providing a total pore volume of about 1 ml/g. This results in a large reservoir within each Microsponge, which can be loaded with up to its own weight in active agent.

III. MICROSPONGE SYNTHESIS

Microsponge particles are conveniently formed by suspension polymerization in a liquid–liquid system (3).

In general, a solution is made comprising the monomers and the functional or active ingredient which is immiscible with water. This phase is then suspended with agitation in an aqueous phase, usually containing additives, such as surfactants and dispersants, to promote suspension.

Once the suspension is established with discrete droplets of the desired size, polymerization is effected by activating the monomers either by catalysis, increased temperature, or irradiation.

The result is a series of polymer "ladders" wrapping around one another into solid microspheres (Fig. 2). As the polymerization process continues, a spherical structure is produced containing thousands of microspheres bunched together like grapes, forming interconnecting reservoirs in which the porogen is entrapped. These reservoirs open onto the surface of the sphere as pores through which the active ingredient can be released when triggered.

Once polymerization is complete, the solid particles that result from the process are recovered from the suspension. The particles are then washed and processed until they are substantially ready for use.

Particle formation and incorporation of the functional substance is thus performed as a single step. This may be termed a one-step procedure.